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The Engineer

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PUBLIC NOTICES

The Director - General, India Store Department, Branch No. 15, Belvedere-road, Lambeth, S.E. 1, invites TENDERS for :—
1. ENGINE BUFFERS and AXLE-BOXES.
2. BUFFER PARTS.
3. LOCOMOTIVE CRANK AXLES.
4. GALVANISED CORRUGATED STEEL SHEETS.
5. MOTOR CONVERTER, La Cour Type, 200 K.W., 6000 A.C./440/220 D.C.
6. STEAM TRAVELLING CRANE.
7. PUMPING SETS, ELECTRIC MOTOR DRIVEN.
Tenders due on the 4th May, 1926, for Nos. 1 to 3, on the 7th May, 1926, for No. 4, and on the 11th May, 1926, for Nos. 5 to 7.
Tender forms obtainable from the above. 2253

Civil Engineer Required by the GOVERNMENT of NIGERIA for the Railway (Capital Works) for a tour of 12-18 months' service, with possible extension. Salary £480 a year for the first three years of service, then £510, rising to £720 by annual increments of £30, and thence rising to £930 a year by annual increments of £40. Free quarters and passages and liberal leave on full salary. Outfit allowance of £80 on first appointment. Candidates, aged 25-35, must have passed examination to qualify for A.M.I.C.E. or hold equivalent professional qualifications and should have had experience as Civil Engineers on Railway Survey and Construction.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, London, S.W. 1, quoting M/14261. 2199

Civil Engineer Required by the GOVERNMENT of CYPRUS for the PUBLIC WORKS DEPARTMENT for three years' service. Salary £500, rising to £800 a year by annual increments of £20. Free passages to and from the Colony for the person engaged and, if married, for his wife and family not exceeding four persons. Candidates, not over 35 years of age, must be fully qualified Civil Engineers and have had previous colonial experience and special knowledge of and experience in the construction and maintenance of Roads and Buildings. Preference given to those who are Associate Members of the Institution of Civil Engineers and who have a knowledge of modern Greek.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, London, S.W. 1, quoting M/14392. 2239

Locomotive Draughtsman and TECHNICAL INSTRUCTOR REQUIRED for the NIGERIAN GOVERNMENT RAILWAY for two tours of from 12 to 18 months, with possible permanency. Salary £480 for the first three years, then £510, rising to £720 by annual increments of £30. Outfit allowance of £80 on first appointment. Free quarters and first-class passages and liberal leave on full salary. Candidates, age 29 to 35, should have served a full apprenticeship on one of the principal British railways and possess subsequent experience of locomotive drawing-office work in a railway drawing-office, which would enable them to take charge of a drawing-office in the absence of the chief draughtsman. They must also be qualified to conduct the classes for apprentices in the Technical School.—Apply at once by letter, stating age and particulars of experience, and mentioning this paper, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/14477. 2198

One Assistant Dredging MASTER REQUIRED for service under the GOVERNMENT OF BOMBAY.
Experience in the working of Suction Cutter Dredgers essential.
Two years' agreement. Free second-class passage to India and return passage on satisfactory termination of services. Pay at the rate of Rs. 660, rising by annual increments of Rs. 50 to Rs. 800 per calendar month. Medical examination.
Forms of application and further particulars may be obtained from the SECRETARY to the HIGH COMMISSIONER for INDIA, 42, Grosvenor-gardens, London, S.W. 1. Last date of receipt of applications 7th May, 1926. 2205

Test Assistant Required for Electro-deposition Work in the Metallurgical Department of the Royal Aircraft Establishment; candidates should preferably have had experience in Electro-deposition of Metals and should have a sound general knowledge of Physics and Chemistry. Preference will be given to ex-Service men. Commencing salary (according to qualifications) from 40s. to 50s. per week, plus C.S.B., giving present total remuneration of 60s. 11d. to 63s. 7d.—Write Reply, quoting A. 112, to SUPERINTENDENT, Royal Aircraft Establishment, South Farnborough, Hants. 2243

PATENTS AND DESIGNS ACTS, 1907 AND 1919.
Notice is Hereby Given that PLATEN-MUNTERS REFRIGERATING SYSTEM AKTIEBOLAG, a company organised under the laws of Sweden, of Stockholm, Sweden, SEEK LEAVE to AMEND the SPECIFICATION of LETTERS PATENT No. 202,650, granted to them for an invention entitled "Improvements in Absorption Refrigerating Apparatus." Particulars of the proposed Amendment were set forth in the Illustrated Official Journal (Patents) of the 8th April, 1926. Any person, or persons, may give notice of Opposition to the Amendment by leaving Patents Form No. 19 at the Patent Office, 25, Southampton-buildings, London, W.C. 2, within one calendar month from the date of the said Journal.
2206 W. S. JARRATT, Comptroller-General.

B. B. and C. I. Railway Company. The Directors are prepared to receive up to Noon on Thursday, 6th May, 1926, TENDERS for the SUPPLY of :—
1. BOLTS, NUTS AND RIVETS,
and up to 2.30 p.m. on Thursday, 6th May, TENDERS for the SUPPLY of :—
2. METALS.
Tenders must be made on forms, copies of which, with specification, can be obtained at these offices on payment of 20s. each for No. 1 and 10s. each for No. 2 (which will not be returned).
The Directors do not bind themselves to accept the lowest or any Tender.
S. G. S. YOUNG,
Secretary.
Offices : The White Mansion, 91, Petty France, Westminster, S.W. 1,
19th April, 1926. 2229

PUBLIC NOTICES

Crystal Palace School of Practical Engineering.
Founded 1872.
MECHANICAL AND CIVIL ENGINEERING DIVISIONS.
PRESIDENT : J. W. WILSON, M.I.C.E., M.I.M.E.
PRINCIPAL : MAURICE WILSON, M.I.C.E.
Assisted by Staff of Lecturers and Instructors.
Thorough, up-to-date Practical and Theoretical Instruction. Course completed in 2 years.
Students admitted at beginning of any term. 2240

Crystal Palace School of Practical Engineering.
Founded 1872.
Principal : MAURICE WILSON, M. Inst. C.E., F.S.E.
Vice-Principal : F. C. P. LAWRENCE, M.S.E., A.M. Inst. Struct. E.
The NEW SESSION will COMMENCE on APRIL 28th. 2203

Bolton Corporation Waterworks.
COMPLETION OF THE BELMONT RESERVOIR REPAIR WORKS.
FOR SALE.
3 Mather and Platt CENTRIFUGAL PUMPS, each electrically dir ct driven, mounted on carriage, capacity 2800 g.p.m. at 70ft. head, motor 65 B.H.P., 1470 r.p.m., 400 v., 3-phase, 50 p.
1 Isles ELECTRICALLY DRIVEN DOUBLE BARREL WINCH, direct and friction drive, capacity 2½ tons direct from barrel, 500ft. 2in. circum. rope in 2 laps each barrel. Motor 25 B.H.P., 400 v., 3-phase, 50 p.
1 Anderson-Grice 3-Ton ELECTRICALLY DRIVEN DERRICK CRANE, 62ft. jib, with PRIESTMAN GRAB. Motor 12 B.H.P., 400 v., 3-phase, 50 p.
1 Inderosoll-Rand E.R.I. AIR COMPRESSOR for belt drive, 223 cu. ft. f.a.p.m. at 100 lb. sq. inch, with air receiver, 8ft. high, 3ft. diam.
1 Yarwood LAUNCH TUG, 29ft. by 8ft. by 3ft. 6in., having timber hull and "Gardner" 3-cyl. 40 H.P. petrol-paraffin engine.
1 Yarwood DROP BOTTOM STEEL HOPPER PONTOON, 35ft. by 14ft. by 4ft. 9in., capacity 30 tons rubble stone, built in sections, suitable for road transport.
About 450 Lin. Yds. 21in. dia. LAP-WELDED STEEL PIPES, S. and S., ¼in. metal.
About 160 Lin. Yds. 12in. dia. WELDLESS STEEL PIPES, flanged, 1 G. metal.
The above plant has been little used, and is in excellent condition.
Further particulars and permission to view may be obtained from, and offers to be submitted to, Mr. JOHN K. SWALES, Waterworks Engineer, St. George's-street, Bolton. 2146

PUBLIC NOTICES

Scarborough Corporation.
NEW IRTON WATER SCHEME.—CONTRACT NO. 5.
CAST IRON PIPES.
The Corporation invite TENDERS for the MANUFACTURE and DELIVERY of about 1000 TONS of CAST IRON REGULAR PIPES and SPECIALS of 15in., and 13in. diameter, together with a small tonnage of 9in., 6in., and 2in. REGULARS and SPECIALS.
The pipes are to be made in accordance with the British Standard Specification.
Copies of the specification and form of Tender, prepared by the Engineer, Dr. H. Lapworth, M. Inst. C.E., 25, Victoria-street, Westminster, may be obtained on application to the undersigned on or after Monday, the 26th April. The application must be accompanied by the sum of £2, which will be refunded on return of the documents within seven days or after receipt of a bona fide Tender and the documents required.
Tenders are to be sent in on the form supplied, and with the specification must be enclosed in a sealed cover, endorsed "New Irton Water Scheme: Tender for Cast Iron Pipes: Contract No. 5," and addressed to the undersigned, reaching him not later than 10 a.m. on Monday, May 10th, 1926.
The Corporation do not bind themselves to accept the lowest or any Tender, and the acceptance of any Tender is subject to the sanction of the Ministry of Health to the loan for carrying out the scheme.
SYDNEY JONES,
Town Clerk.
Town Hall, Scarborough,
April 16th, 1926. 2208

The South Indian Railway Company, LIMITED.
The Directors are prepared to receive TENDERS for the SUPPLY of :—
1. LOCOMOTIVE ENGINES and TENDERS.
2. ROOF WORK.
Specifications and forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W. 1.
Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked "Tender for Locomotive Engines and Tenders," or as the case may be, must be left with the undersigned not later than Twelve Noon on Friday, the 14th May, 1926.
The Directors do not bind themselves to accept the lowest or any Tender.
A charge, which will not be returned, will be made of £2 for each copy of Specification No. 1, and of 10s. for each copy of Specification No. 2.
Copies of the drawings may be obtained at the offices of the Company's Consulting Engineers, Messrs. Robert White and Partners, 8, Victoria-street, Westminster, S.W. 1.
W. B. REYNOLDS,
For Managing Director.
91, Petty France, S.W. 1,
21st April, 1926. 2251

PUBLIC NOTICES

Great Southern Railways.
WORKING OF QUARRIES BY CONTRACT.
The Directors of the Great Southern Railways are prepared to consider PROPOSALS from contractors for WORKING the Company's STONE BALLAST QUARRIES at Lisduff (near Templemore) and Lecarrow (near Knockcroghery, Co. Roscommon).
The output of stone ballast from the quarries was about 67,000 tons to 47,000 tons respectively in 1925.
Full particulars can be obtained from the Chief Engineer, Mr. J. F. Sides, M. Inst. C.E., Broadstone Station, Dublin.
C. E. RILEY,
Secretary.
Kingsbridge Station, Dublin,
April, 1926. 2242

Rochester and Chatham Joint Sewerage Board.
MAIN OUTFALL SEWER AND DISPOSAL WORKS.
CONTRACT NO. 4.
The Board is prepared to receive TENDERS for the COMPLETION of the CONSTRUCTION of the MAIN OUTFALL SEWER, consisting of Laying about 2194 Yards of 36in., 33in., and 32in. Cast Iron Pipes in double pipe line; and the Construction of about 241 Yards of Concrete Sewer Culvert, also 5ft. 3in. high by 3ft. 6in. wide, together with appurtenant works. Also for the CONSTRUCTION of NEW SEWAGE DISPOSAL WORKS, comprising Grit Tanks, Screens, Sewage Carriers, Storm Tanks, Settling Tanks, Sludge Drying Beds, Power-house, Pump-house, Offices, and all appurtenant Works at Molmy Hill, near Rainham, Kent.
Also for LAYING about 994 Yards Lineal of 24in., 36in., and 42in. CAST IRON PIPES on the site, and 494 Yards Lineal of 36in. and 42in. CAST IRON TIDAL OUTFALL PIPES on WOOD PILING.
The works are part of the Board's scheme of sewerage which is approved for grant by the Unemployment Grants Committee, and that Committee has laid down as a condition that all contracts for or incidental to the works are to be placed in this country.
The Board will require that all goods and materials supplied shall be of British production and manufacture.
Plans may be seen and quantities and form of Tender obtained on and after the 19th April at the office of the Engineers, Messrs. W. H. Radford and Son, Chartered Civil Engineers, Albion Chambers, King-street, Nottingham, and also at my office, as under, on deposit of Ten Guineas (cheque), which will be returned on receipt of a bona fide Tender and the return of the quantities, &c.
Sealed Tenders, endorsed "Contract No. 4—Disposal Works," to be delivered to me at my office, as under, on or before the 29th May, 1926.
The Board does not bind itself to accept the lowest or any Tender.
By Order,
R. W. WATKINS,
Clerk to the Board.
13, New-road, Chatham Kent,
April 12th, 1926. 2144

Rochester and Chatham Joint Sewerage Board.
MAIN OUTFALL SEWER AND DISPOSAL WORKS.
CONTRACT NO. 5.
TO IRONFOUNDERS.
The Board is prepared to receive TENDERS direct from ironfounders for the SUPPLY and DELIVERY at Rainham Station, near Chatham, Kent, of about 2500 TONS of CAST IRON PIPES and SPECIALS.
The Pipes and Specials will be 42in., 36in., 33in., 32in., 24in., 18in., 12in., 9in., 6in., and 3in. diameters, and will be mostly British Standard Spigot and Socket Class.
The Pipes and Specials are required in connection with the Board's scheme of sewerage and sewage disposal, which is approved for grant by the Unemployment Grants Committee, and that Committee has laid down as a condition that all contracts for or incidental to the works are to be placed in Great Britain.
The Board will require that all goods shall be of British production and manufacture.
Quantities, form of Tender, specification and conditions of contract may be obtained on and after the 19th April from the office of the Engineers, Messrs. W. H. Radford and Son, Chartered Civil Engineers, Albion Chambers, King-street, Nottingham, on deposit of Three Guineas (cheque), which sum will be returned on receipt of a bona fide Tender and the return of the quantities, &c.
Sealed Tenders, endorsed "Contract No. 5—Ironwork," to be delivered to me at my office, as under, on or before the 29th May, 1926.
The Board does not bind itself to accept the lowest or any Tender.
By Order,
R. W. WATKINS,
Clerk to the Board.
13, New-road, Chatham, Kent,
April 12th, 1926. 2145

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PUBLIC NOTICES

Parish of Reading.

TO BUILDERS, TALL CHIMNEY ERECTORS, HEATING ENGINEERS AND OTHERS.

The Guardians of the Poor of the Parish of Reading invite APPLICATIONS from firms willing to TENDER for any or all of the undermentioned WORKS at the Battle Infirmary, Reading, viz.:—

SECTION 1.—The Conversion of Old Laundry Buildings into a Power-house, the Formation of Subways and other Building Works.

SECTION 2.—The Boiler Seatings, Economiser House, 120ft. Chimney Shaft, and Works accessory thereto.

SECTION 3.—The Works comprised in Sections 1 and 2 collectively.

SECTION 4.—The Lancashire Boilers, Economiser, Heating Calorifiers, Hot Water Calorifiers, Feed Pumps, Circulating Pumps, Valves, Pipes, Tanks, &c., in and about the Boiler-house and Calorifier Chamber, also the Water Softening Plant.

SECTION 5.—The Heating and Hot Water Mains, Valves, &c., from the Calorifier Chamber to the various Blocks, the Internal Heating and Hot Water Service in the various Blocks, and Connecting to existing Service where necessary.

SECTION 6.—The Works comprised in Sections 4 and 5 collectively.

Quantities for Section 1 and quantities, plans and specifications for Section 2 will be supplied by the Board's Architect, W. Roland Howell, Esq., F.R.I.B.A., 17, Blagrave-street, Reading.

Plans and specifications for Sections 4 and 5 will be supplied by the Board's Engineer, J. Wayne-Morgan, Esq., M.I. Mech. E., 9, Mount Stuart-square, Cardiff.

The contracts for Sections 1 and 2 will be on the lines of the R.I.B.A. form, and for Sections 4 and 5 on the lines of the form issued by the Institute of Heating and Ventilating Engineers.

The firm whose Tender or Tenders may be accepted will be required to give security, to be approved by the Guardians, for the due performance of the contract, and to pay to the workmen employed on, or in connection with, the work, the appropriate trade union rate of wages.

Persons desirous of tendering must, in the first place, make application to the Clerk to the Guardians, on or before the 3rd May next, and must send with the application a deposit of £3 in respect of each Section for which they wish to Tender. Such deposits will be returned in full on receipt of a bona fide Tender in the manner and at the time which will be appointed by the Board.

The Board does not bind itself to accept the lowest or any Tender.

By Order of the Board,
W. H. OLIVER.
Clerk to the Guardians.

Guardians' Offices,
32, Thorn-street, Reading.
19th April, 1926. 2213

Port of Bristol Authority.

The Bristol Docks Committee REQUIRE the SERVICES of a JUNIOR ELECTRICAL ENGINEER. Salary about £220 per month.

The duties will be to assist in the supervision of the repairs and maintenance of the electrical installation at the Avonmouth Docks, which includes electric motors on the grain machinery, cranes and general plant, electric lighting and underground cable system, with the various distribution switchboards, &c.

Applicants are required to state their age, training, previous employment, present position, and present or most recent salary.

Applications should be received by the Chief Engineer not later than Monday, the 3rd day of May, and should be accompanied by copies of three most recent testimonials. The appointment will be held during the pleasure of the Docks Committee.

THOMAS A. PEACE,
Chief Engineer,
Port of Bristol Authority.

Chief Engineer's Office,
Avonmouth Docks,
April, 1926. 2154

The Assam-Bengal Railway

COMPANY, LIMITED.

2 ASSISTANT CIVIL ENGINEERS.

REQUIRED for service on the above Railway, TWO ASSISTANT CIVIL ENGINEERS, who must have had a good general and technical education at a recognised engineering college, and have obtained a degree or passed the A.M. Inst. C.E. examination.

SALARY.—Rupees 525 per calendar month.

TERMS.—A three years' agreement in the first instance, and first-class free passage to India.

The selected candidates will be required to pass a strict medical examination before appointment.

Applications (by letter only), giving full particulars of candidates' general and technical education, together with details of practical experience, if any, must be addressed to the undersigned not later than 7th May, 1926.

By Order of the Board,
THOS. C. BRETT,
Acting Secretary.

19th April, 1926.
Bishopsgate House,
80, Bishopsgate, E.C. 2. 2218

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

WANTED AT ONCE for Large Indian Railway Wagon Works, young and energetic MAN of first-class education and address, with some experience of Wagon Construction, to act as Personal Assistant to General Manager. Excellent prospects for right man.—Applications and further details to be had from "Z. Y. 732," c/o Deacon's Advertisement Offices, Fenchurch-avenue, London, E.C. 3. 2225 A

WANTED, ENGINEER, 28/32 Years, Educated, technical and workshop training, experience of high production methods, modern labour-saving devices.—Address, giving particulars of education, training, and experience, 2129, The Engineer Office. 2129 A

ASSISTANT ESTIMATOR, with Knowledge of trade. State age, experience, wages.—H. and T. DANKS (NETHERTON), Ltd., Dudley. 2252 A

BOILER INSPECTORS and Others in Touch with Steam Users to give INTRODUCTIONS for a NEW SYSTEM on commission basis.—Address, P1841, The Engineer Office. P1841 A

CONSULTING ENGINEER and MANUFACTURER has an OPENING in his London Office for a PREMIUM PUPIL. Must have a good general education, some knowledge of drawing an advantage. Would be given a thorough training with a view to a permanent post when proficient. Interview by appointment.—Address, 1986, The Engineer Office. 1986 A

ENGINEERING SALESMAN REQD. by Firm representing very important Continental Machinery Manufacturers. Commercial ability, engineering training and fluent German indispensable. Age about 25. State qualifications fully and salary requd. Must be prepared travel U.K. Permanent situation suitable man.—Address, 2245, The Engineer Office. 2245 A

ESTIMATING ASSISTANTS.—JUNIOR REQUIRED; experience Water-tube Boilers, Accessories, Power Station Equipment essential. State experience, salary required.—Address, P1825, The Engineer Office. P1825 A

FIRST-CLASS PRODUCTION and MAINTENANCE ENGINEER REQUIRED for Large Midland Firm of Ironfounders and Machinists. State fully experience and salary required.—Apply, Box 732, Mundy, Gilbert and Tromans, Advertising Offices, Birmingham. P1815 A

ARNOLD BOOKS

JUST 8 PUBLISHED.

A Unique Production.

THE ENLARGED MOLLIER DIAGRAM
FOR SATURATED AND SUPERHEATED STEAM.
Drawn by PROFESSOR H. L. CALLENDAR, F.R.S.,
from the values obtained from his equations for "The Properties of Steam," and printed in 3 colours on squared paper, 33 × 28 inches. Price 4s. net. (by post in a tube 4s. 9d.)

PROPERTIES OF STEAM & THERMO-DYNAMIC THEORY OF TURBINES.
By H. L. CALLENDAR, F.R.S., Professor of Physics in the Imperial College of Science and Technology. 544 pages, numerous Diagrams. 30s. net.

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80 pages. Demy 8vo. 7s. 6d. net.

HERTHA AYRTON 1854—1923. A Memoir
By EVELYN SHARP.
With Illustrations. *One Volume.* 15s. *net.*
Mrs. Ayrton shares with her old friend, Mme. Curie, the honour of being the first among the rapidly increasing band of women who have achieved real distinction in the scientific world.

THE ITALIAN ORDERS OF ARCHITECTURE.
By PROF. CHARLES GOURLAY, B.Sc., A.R.I.B.A., Royal Technical College, Glasgow.
With 32 full-page Plates. SECOND EDITION. Large 4to (12in. × 9½in). 8s. net.

FUEL: Solid, Liquid, and Gaseous.
By J. S. S. BRAME, F.I.C., Professor of Chemistry, Royal Naval College, Greenwich.
THIRD EDITION. 18s. net.

LONDON: EDWARD ARNOLD & CO. 41 & 43, MADDOX ST., W.

SITUATIONS OPEN (continued)

FACTORY SUPERINTENDENT REQUIRED by a Firm of Electrical Engineers, to Take Charge, under Works Manager, of the Switchboard Department employing about 1000 men. Must be energetic and have good organising abilities.—Address, giving full details of experience and qualifications, &c., 2233, The Engineer Office. 2233 A

REQUIRED in India, Fully Qualified and Experienced ENGINEER for Execution of a Contract covering Construction of Three Tunnels in Trap Rock and about Two Miles Re-alignment of Main Line Track; duration of engagement about two years. Candidates should be thoroughly competent to organise necessary plant and methods of construction from inception to completion of job, and not over 40 years of age. Free furnished quarters and passage out and home. Good climate and healthy station.—Write, stating full particulars and experience, with salary required, to "Z. G. 718," c/o Deacon's Advertising Offices, Fenchurch-avenue, London, E.C. 3. 2226 A

WORKS MECHANICAL ENGINEER WANTED for Port Sunlight, Cheshire. Must have sound practical and scientific engineering training, and be familiar with engineering requirements for a large industrial concern, with a general knowledge of Evaporating, Extraction, Distilling, Hydraulic and Compressed Air Installations, &c.

Strict disciplinarian with up-to-date organising abilities, and with modern methods of workshop management for economical production. Capable of supervising the preparation of plans and estimates and taking entire responsibility for the erection of new and development work. Candidates must be healthy and of good physique, and character must bear the strictest investigation. Applicants to state whether married or single, salary required, age, and full qualifications, together with copies of testimonials.

Applications to be addressed, "Private," "ENGINEER APPOINTMENT," c/o Office Services Dept., Messrs. Lever Bros., Ltd., Port Sunlight, Cheshire. 2219 A

WANTED AT ONCE, CHIEF DESIGNER by Well-known Structural Steel Work Firm in Manchester.—Address, 2215, The Engineer Office. 2215 A

WANTED, DRAUGHTSMAN, Preferably with experience in Cement Works Plant.—Apply, giving particulars of experience and salary required, to MAXTED and KNOTT, Ltd., Dunstable. 2250 A

WANTED IMMEDIATELY in London District, first-class MECHANICAL DRAUGHTSMEN. Must be expert in designing Medium-weight Intricate Mechanisms.—Address, stating age, salary, 2248, The Engineer Office. 2248 A

CIVIL ENGINEERING DRAUGHTSMEN.
First-class MEN REQUIRED, with wide experience in the design of:—
1. Constructural Steel Work.
2. Reinforced Concrete.
3. Dock Walls and River Works.

None but experienced men need apply.—Address, stating age, experience, salary required, &c., 2207, The Engineer Office. 2207 A

COACHWORK DRAUGHTSMAN REQUIRED, Able to get out specifications and estimates, by Firm of Commercial Chassis Builders. Particulars of age, experience, and salary required.—Address, 2212, The Engineer Office. 2212 A

DRAUGHTSMAN DESIGNER REQUIRED, London-for Calculations and Design of Steelwork for Bridges, Factories, Jetties, &c. State experience, age and salary required.—Address, 2122, The Engineer Office. 2122 A

DRAUGHTSMAN, Junior, 18-22, for Conveying and Screening Engineers, Westminster.—Address, P1831, The Engineer Office. P1831 A

DRAUGHTSMAN, Mechanical, London District, WANTED. State age and particulars of past experience. Salary minimum basic rate 57s. 6d. plus Civil Service bonus; total approximately on minimum rate 93s. 10d. per week. An ex-Service man, if fully qualified, will be preferred.—Box 1944, c/o Pool's Advertising Service, 180, Fleet-street, E.C. 2233 A

DRAUGHTSMAN REQUIRED for London Office of Constructional Engineers, capable of designing Steel Work and preparing quantities for estimating.—Address, stating age, experience, and salary required, 2210, The Engineer Office. 2210 A

SITUATIONS OPEN (continued)

DRAUGHTSMAN REQUIRED IMMEDIATELY, with experience in Water-tube Boilers.—Address, stating age, experience, and salary, and when at liberty, 2231, The Engineer Office. 2231 A

DRAUGHTSMEN REQUIRED, Preferably with experience on Aircraft Engine Design.—Address, stating age, experience, and salary required, to the BRISTOL AEROPLANE CO., Ltd., Filton, Bristol. 2241 A

DRAUGHTSMAN (SENIOR) WANTED for Constructional Steel Work in Midlands. Well accustomed to the full routine of a Constructional Engineer's Estimating and Order Office. Well up in calculations and stresses. Say when disengaged, wages required, age, and fullest particulars.—Address, 2235, The Engineer Office. 2235 A

DRAUGHTSMAN WANTED for Railway Construction Office in Spain. Salary £350 to £400 per annum, according to qualifications.—Apply, stating age, experience, and references, to COUPER and KER, 4, Dean's-yard, S.W. 1. P1845 A

DRAUGHTSMAN WANTED (Manchester District). Must be capable of designing Rubber and Hydraulic Machinery. State age, experience, and salary required.—Address, P1840, The Engineer Office. P1840 A

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For continuation of Small Advertisements see page 3.

A Seven-Day Journal

The Damage to H.M.S. Emerald.

EARLY this month the cruiser Emerald, which had recently arrived on the East Indies Station, developed defects that were alleged to be of a serious character. Press messages stated that sea water was entering the fresh-water tanks, and that the condition of the ship gave cause for anxiety. She was placed in dock at Colombo, where an inspection showed that the damage called for more extensive repairs than could be undertaken by the local yard. The Emerald has therefore sailed for Malta, where she will be thoroughly overhauled. The fact that she is making this long voyage indicates that the first reports of her unseaworthiness were greatly exaggerated. Nevertheless, an incident of this kind is so rare in the British Navy that it is bound to cause remark. The Emerald was laid down by Armstrong, Whitworth and Co. two months before the Armistice. In common with other unfinished ships of the war programme, her completion was retarded in the interests of economy, and after being launched in May, 1920, she was towed to Chatham Dockyard to be fitted out. There she remained for well over five years. This policy of slowing down work on warships, although prompted by motives of economy, has proved extremely wasteful, and it has had the further disadvantage of unduly exposing such ships to the processes which tend to the deterioration of their structural material. The Emerald and her sister ship Enterprise are the fastest cruisers hitherto built for the Royal Navy. They have geared turbines of 80,000 horse-power for a speed of 33 knots, but since no details of the trials were released, it is not known whether this speed was actually attained.

Woolwich Royal Dockyard and Arsenal.

IN the course of a speech given at a dinner of the Royal Arsenal Association of Foremen and Draughtsmen on Saturday evening last, Sir Kingsley Wood made reference to the impending sale of Woolwich Dockyard. The sale of the yard by auction, he stated, has been fixed by the Admiralty for June 8th, and it will take place at the London Auction Mart. It is expected that the fine river frontage of 1400ft., with its deep water berths and some 25 acres of land, including about 70,000 square feet of permanent buildings, will attract private firms to the borough. Referring to position at the Arsenal, Sir Kingsley Wood expressed his personal regret at the discharges which had taken place. On the other hand, it was, he said, to be borne in mind that Woolwich was now receiving more orders in proportion to the amount of work which was available than at any time in its history. He added that over one million pounds worth of orders would be given to ordnance factories, of which Woolwich Arsenal would receive something like two-thirds, as compared with one-third which would go to private ordnance firms.

Wireless Beam Stations.

THE beam wireless station now in course of erection at Bodmin for transmitting messages to Canada and South Africa will be completed by the middle of May, and the receiving station at Bridgewater will be ready before that date. The corresponding stations in Canada will be ready for working at about the same time, and also the receiving station in South Africa. The South African transmitting station will not, however, be finished before the end of June, and the beam system of wireless communication will therefore come into operation first between this country and Canada. More or less definite dates have been fixed for the completion of the other beam stations in England for communicating with India, the Far East and Australia. The transmitting station at Grimsby is scheduled for completion on June 11th, and the receiving station at Skegness will be ready on the same date. Both the stations in India will also be completed about the same time, but while Australia will be able to receive messages by means of the wireless beam on June 11th, it will not be able to transmit messages to England until the end of July. The Marconi Company is erecting a station for its own use near Dorchester for communication with the United States and with South America. While all these beam stations will be ready for working about midsummer, a period for experiments and testing must, of course, elapse before the stations can be opened for regular commercial service.

Scientific "Jargon."

WE confess to a good deal of sympathy with Mr. T. J. Kennedy, chairman of the Cold Rolled Brass and Copper Association, in his plea for the use of simpler language in the reports of research workers. Speaking at the annual luncheon on the 20th in Birmingham of the British Non-Ferrous Metals Research Association, he expressed the opinion that some of the research workers' reports, while doubtlessly very valuable, were, because of their scientific "jargon," as unintelligible to the average business man as they would be if they were addressed to him in Russian. The language of pure and applied science is becoming complicated and specialised with a rapidity that is truly alarming. New words and phrases are coined and applied often, we fear, with little provocation and frequently with disrespect, both to the rules of etymology and the dictates of self-explanation. To label a characteristic with some new name rather than to resolve it in terms of familiar conceptions seems at times to be the research worker's chief object. The position is in fact approaching the state which chemistry would occupy if the chemists, abandoning their faith in the existence of a limited number of primitive elements, sought to pursue their studies by dealing with all compounds as separate entities, incapable of resolution into components. It would be invidious and unjust to single out research workers in any one field of investigation as particularly bad offenders in the matter of scientific jargon, but we feel justified in saying that those engaged in metallurgical research are not among the least blameworthy. At Tuesday's meeting Mr. Thomas Bolton, the chairman of the Research Association, was at pains to emphasise that the establishment of the Association did not remove the necessity for members individually retaining the services of scientific men. It may well be that such men will be required in the near future to do nothing else but interpret the reports of the research workers for the benefit of their employers. Without their services it is seriously conceivable that much of the research work now being conducted in this country will end solely in a cloud of words wholly without meaning, and therefore without interest, to those for whose good and at whose expense it is being conducted.

Pictures by Wireless.

ON Tuesday, April 20th, the Hon. A. B. Houghton, the American Ambassador, paid a visit to Radio House, Finsbury, for the purpose of seeing messages transmitted to New York by the photo-radio system, invented by Captain R. H. Ranger, the development engineer of the Radio Corporation of New York. Captain Ranger has come to England with the object of demonstrating the practicability of opening up a commercial service for the transmission of pictures and messages by wireless by means of his photo-radio apparatus, which has been installed on the top floor beneath the skylights of Radio House. Next to it is a replica of the receiving machine in New York by means of which those present at last Tuesday's demonstration were able to see the progress of their messages as sent out from Carnarvon, to which station they were sent by land line. The first "message" dispatched was a cheque for 1000 dollars on the Bankers' Trust Company, signed by General Harbord. The receipt of the cheque in New York was acknowledged by Morse within about twenty minutes of its being placed in the transmitter. Captain Ranger is confident that in the near future it will be possible to give a demonstration of the dual process of transmission and reception between England and America, instead of a one-way demonstration as witnessed last Tuesday.

A New Wearmouth Bridge.

IT is announced that a contract for the building of a new bridge over the river Wear at Sunderland has been placed with Sir William Arrol and Co., Ltd., of Glasgow. The work, it is understood, will be completed within thirty-two months, during which time there will be no interference with either the road or the river traffic. The design for the new bridge was prepared by Messrs. Mott, Hay and Anderson, Westminster, consulting engineers to the Sunderland Town Council. The bridge will be of the two-hinged parabolic steel arch type, with a span of 310ft. It will measure 296ft. between the abutments, and have a 68ft. rise to the axis of the ribs at the centre of the arch. A total width of 80ft. between the balustrades, including the girders, will give a carriageway 48ft. in width, carrying two lines of trams and two footways each 12ft. 6in. wide. The two main ribs will be spaced 55ft. apart, and the footways, with the gas and the electric light and power mains, will be carried on side brackets. Steel caissons sunk into the bed of the river will support the masonry construction, which will be taken up to nearly street level, at which the bearings of the bridge are to be placed. To prevent interference with traffic the main ribs, the bracing, and the hangers of the new bridge will be erected first, and then a temporary roadway supported by the new bridge will be built over the existing structure. Traffic will then be diverted to this roadway while the old structure is removed. It is estimated that the total cost of the new bridge will amount to about £230,340.

Railway Development in Russia.

THE reports of the speeches which were made at the recent Eighth Congress of Railway Workers in Moscow would seem to reveal a somewhat unsatisfactory position as regards the immediate future of railway development in Russia. Apparently there continues to be a considerable shortage both of rolling stock and of locomotives, and although a large number of 40-ton trucks have been on order for some time, there appears to be little chance of their being delivered. Indeed, it is stated that the railway works are only slowly becoming accustomed to wagon building. The repair shops, too, are overloaded and are, it is said, badly handicapped for lathes, much of the work having to be done by hand. Metal supplies are scarce, and during the first four months of the financial year repairs had already fallen short of the arranged programme of work by some ninety-seven locomotives and 1367 trucks. The condition of the permanent way is also said to be causing anxiety, and the high cost of wooden sleepers seems to limit the original programme both of track replacement and of new construction. It is pointed out that relief might be obtained by ordering trucks from abroad, but such a procedure would upset the balance of foreign trade. It is understood that the re-equipping of the railway workshops has had to be delayed owing to the inability of the Soviet works to supply lathes for some time to come and the reduced vote of money to be expended for this particular purpose. Meanwhile progress with Russian railway development work in Germany continues to be made. Last week the official trials of the direct-driven Diesel locomotive designed by Professor G. Lomonossoff and built at the Hohenzollern Locomotive Works at Düsseldorf were successfully carried out.

Low-Temperature Carbonisation.

IN a statement made during the week by Dr. C. H. Lander, Director of the Fuel Research Board, the present position of low-temperature carbonisation in this country, so far as the Department of Scientific and Industrial Research is concerned with it, was briefly indicated. About eighteen months ago the Department, it will be recalled, was empowered to test, free of charge to the owners, low-temperature carbonisation plants provided the Director of Fuel Research was satisfied before the test that the plant was giving reasonably good results and provided that the owners gave the Department the right at its discretion to publish a report on the test. Five such test have, Dr. Lander stated, now been completed and two reports published, namely, those on the Low Temperature Carbonisation Company's plant at Barnsley and on the Midland Coal Products Company's plant at Netherfield, Nottingham. Reports on the Freeman retort, the Fusion retort, and the "L. and N." retort are not as yet quite ready for publication. In addition to these five tests rough tests on two German plants have been made. Dr. Lander stressed the points that no attempt can be made to generalise concerning the commercial possibilities of the plants tested, and that it is extremely unlikely that any one standard type will ever be adopted to the exclusion of others. Several British processes, he said, had passed through the large-scale experimental stage and had reached the next stage involving the erection of a plant of commercial size for the purpose of obtaining definite information as to running costs, life, &c., over a period of, say, three years. The McLaurin plant at Glasgow was, he remarked, now working on this scale, and plants of commercial size were being erected by Illingworth Carbonisation, Ltd., and Leigh Smokeless Fuels, Ltd., while the "L. and N." Company had received, it was understood, definite orders for two plants, each of 100 tons a day capacity. The operation of suitable plants under commercial conditions for a period of years would determine whether low-temperature carbonisation was an industry that had come to stay.

The Engineering Dispute.

ON Thursday of last week, April 15th, the dispute in the engineering industry underwent development by reason of the submission of new proposals by the employers to the union representatives. It is exactly a year to-day since the employers suggested their first set of terms. Those terms proposed the extension of the working week from 47 hours to 50 and 52½ hours for the day and night shifts respectively, an increase in the war bonus from 10s. to 12s. per week, and a reduction of the night shift and overtime extras from the maximum of one-third and two-thirds to one-quarter and one-half respectively. The night shift and overtime allowances were to be calculated on the base rate wages and not as previously on these rates plus the war bonus. The new terms submitted by the employers last week embodied an offer "to mortgage the future of the industry" by increasing the war bonus from 10s. to 12s. 6d. per week, the overtime rates to be reduced in accordance with the proposals of April 23rd, 1925. The important variation in these proposals was not the rise in the increase of war bonus offered, but the omission of the demand for an extension of the working week. Although the extra bonus would mean an increase of £3,250,000 per year in the wages distributed to the members of the unions and would be received in full by at least 95 per cent. of them, the union representatives declined to accept the new proposals and to continue negotiations on the basis involved in them. On Friday, April 16th, the negotiations broke down without any arrangement being made for their resumption. On Monday, the 19th, the London Joint Trades Committee of the Engineering Industry decided to issue ballot papers, returnable by May 31st, on the question of striking to enforce the original demand for an all-round increase of 20s. per week.

Some Aspects of Friction.

By W. A. BENTON.*

No. III.†

It is proposed to conclude these notes with a few words on rolling friction, the theory of which was worked out by Osborne Reynolds. He proved that the depression and accompanying crest made by a roller on a rail or road surface was of the nature of a wave, and that both the formation of the depression in front of the roller and its obliteration behind it hindered the progress of the roller, and constituted the main component of rolling friction. It is not proposed to make a study of Reynolds' theory, but to proceed to a short consideration of the static coefficient of rolling friction.

In the text-books various estimates of this coefficient will be found. It has been universally recognised that it is very much less than the coefficient of sliding friction—on all except exceedingly soft surfaces. Not only have the coefficients given in pocket-

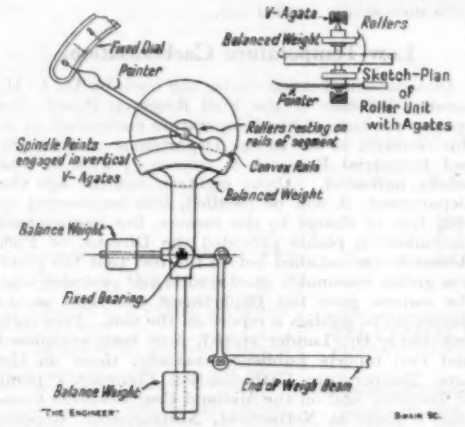

FIG. 4—AUTHOR'S APPARATUS FOR MEASURING STATIC COEFFICIENT OF ROLLING FRICTION

books and text-books differed greatly from one another; they have also in every instance, the author holds, been given values which are much too great.

It is often, however, difficult to make comparisons. Sometimes the compilers or experimenters have given what they believe to be the actual frictional coefficient of a free, weighted, balanced roller on a rail or plane surface; that is, the static coefficient which would correspond exactly to the tangent of the angle of inclination of a plane at which the free roller would begin to roll. Obviously, this is not the coefficient given by Professor Perry when he speaks of rollers between flat cast iron plates, and estimates their resistance to rolling in pounds per pound of load as given by $c/\sqrt{r}$. For cast iron c is given as 0·0063, for wrought iron 0·0120, and for steel 0·0073.‡ For a smooth cast iron roller 1¼in. in diameter between smooth cast iron plates this formula gives a coefficient (whether static or not the author does not know) of 0·0056. Dividing by two to get the coefficient for a free roller on one plane, we get 0·0028—a value from eight to ten times too great, if the results of the author's experiments can be relied on.

As a matter of fact, it is extremely difficult to obtain reliable coefficients by the method mentioned above, and it has only been by taking elaborate precautions that the U.S.A. Bureau of Standards has recently been able to determine reliable coefficients for balls and rollers working between plates. An account of the work was published in 1921 as No. 201 of the Bureau's Technologic Papers. The tests dealt with balls of 1·00in., 1·25in., and 1·50in. in diameter in grooved races; and with rollers 1·25in. in diameter and 5·25in. long in flat and cylindrical races. The results obtained showed that the ratio of friction to load is practically constant and equal to 0·00055 for all three sizes of balls up to a critical load which was 1300 lb. for 1·00in. diameter balls, 1700 lb. for 1·25in., and 2200 lb. for 1·5in. diameter balls. The ratio of friction to load for the rollers was 0·00075, and the critical load 25,000 lb.

The total deformation and area of contact of the bearings and races were measured and compared with Hertz's theory. The static friction of a ball 1in. diameter for a load of 250 lb. was only 0·00024. A 1·25in. diameter ball at 250 lb. pressure gave a frictional coefficient of 0·00032. A 1½in. diameter roller under 250 lb. gave a static coefficient of 0·000250. The results varied with the hardness of the balls, and to some extent, of course, with the ratio of roll diameter to load, but this ratio presents interesting features. With loads as low as 250 lb. the larger ball gave the higher coefficient. At very heavy loads the opposite variation was observed, as is clear from the critical pressures.

I was unaware of the American determinations right up to the practical completion of my work, when the Skefko Ball Bearing Company, with whom I had been in correspondence, very kindly called my attention to the recent publication. I understand that the railway companies for many years past have recognised static coefficients varying from 0·004 to 0·005 for chilled iron or steel wheels rolling on steel rails.

Of text-books and pocket-books, Duncan, basing his statement on experiments made by the Hoffman Company, gives the value of the coefficient (presumably for moving rolling friction) as 0·0015 in the case of hardened steel balls on hardened steel races.

"Machinery's Handbook" gives 0·002 to 0·005 as the rolling frictional coefficient of iron on iron.

Goodman gives the following formula which is based on a simplification of the Reynolds' deformation datum:—

P = tangential force applied to axis parallel to surfaces.

W = weight of roller or load acting vertically downwards through axis.

A c = K = ½ chord of depression in surface made by wheel.

R = radius, and h = depression.

$$P \times \overline{BA} = W \times K.$$

$$P = \frac{W \cdot K}{R - h}$$

In case of all hard surfaces h is very small compared with R.

Hence we may write

$$P = \frac{W \cdot K}{R} \text{ (nearly).}$$

Goodman says the relation works fairly well in practice. He gives a table of values for K in inches. I quote two only:—

Iron or steel wheels on iron or steel rails, 0·007 to 0·015.

Pneumatic tires on good road, 0·09 to 0·11.

Taking a value of K = 0·009 for a steel wheel 32in. in diameter loaded to a total weight of 2240 lb. on a steel rail, I have calculated the proximate value of the coefficient of rolling friction for these conditions as given by the above formula.

The coefficient (presumably *not* the static coefficient of rolling friction) is 0·00056 approx.

Now, while this value is probably nearly twice as great as the true value, it is many times nearer the true value than any figure given—so far as my knowledge goes—in any text-book for many years after the publication of the formula. In fact, it was not till the Bureau of Standards' pamphlet was published that anything better was known. It should here, however, be pointed out that in practice railway wheels heavily loaded bend the rails between the sleepers quite apart from the "Reynolds' depression," and this introduces a new factor making the actual friction greater than it would be if the surface were rigid.

The author was led to attempt a re-estimation of the static coefficient of rolling friction partly because it was evident from the sensitivity of certain rolling parts in various types of weighing mechanism that the usually accepted figures were too high, and partly because an examination of Osborne Reynolds' theory and a comparison of it with expressions theoretically deduced from known data made it certain that something was wrong. His first experiments were made with steel balls and cylinders on polished plate glass, and also on steel surface plates. An attempt was made to evaluate the constant by first getting the plates absolutely level by means of a specially sensitive spirit level, and then determining the angle of slope required to set a steel ball or roller in motion on the plate.

Practically insuperable difficulties were experienced in getting really reliable results, but sufficient data were obtained to make it quite certain that the value of the coefficient was very much less than any figure that had hitherto, to the best of the author's knowledge, been published. In this method the required coefficient is obtained directly from the tangent of the angle of inclination and the known weight of the roller or ball.

It was decided to attack the problem along quite new lines. A segment of a circle—see Fig. 4—was mounted on a knife-edge at its centre, and counterbalanced by a pendulum so as to be just in stable equilibrium. A short arm fitted with a knife edge projected from the centre, and from it a very minute weight pan was suspended. Exactly above the fulcrum a weighted roller was arranged, so as to be entirely supported by the rails of the segment. The roller was exactly 1¼in. in diameter. A long delicate pointer was attached to the roller, and a chart with a few very fine divisions marked on it was disposed so that any movement of the pointer could be observed directly or with a magnifying glass. Both the roller and the segmental rails were made of phosphor bronze, and very accurately turned in Messrs. Avery's experimental department. The greatest error of excentricity of the segment measured from the knife edge, as determined by five sets of measurements, did not exceed about one-half of one-thousandth of an inch. In order to prevent the roller from falling, it was fitted with a spindle having hardened steel points, which engaged with two selected agate V bearings, so arranged that the apex lines of the V's were perfectly vertical.

In the original experiments for determining the coefficient of rolling friction the adjustment of the bearings to the ends of the spindle was effected by means of screws, and a minute amount of play, estimated at about one-thousandth of an inch, was allowed. In the majority of the experiments the weight of the loaded roller—which, of course, had to be statically balanced with very great care—was so proportioned that a poise designed to give a tangential force of two grains at the point of contact of the common tangent of the roller and the segment was just sufficient to move the pointer.

When this apparatus had been completed difficulty was experienced in carrying out the experiments by reason of the incessant vibration inevitable in a large works, and most of the experiments had to be made when no machinery was running. Dust and minute greasy particles of smoke did not help the work, but by care and watchfulness the author at length succeeded in obtaining such a large number of reasonably consistent results as to justify him in thinking that sufficient data were available for the determination of the coefficient. The mean value obtained for the phosphor bronze roller and segment was 0·00022. As regards the probable correctness of this value, it was estimated at first, by well-known probability methods, that the figure might be either greater or less by 0·00003, but more recent determinations, and a re-examination of the figures, lead to the belief that the actual coefficient is probably rather less than the figure originally found, and that it may not be greater than 0·00019.

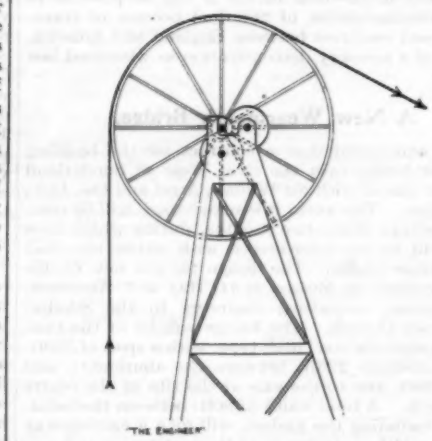

FIG. 5—ANTI-FRICTION WHEELS APPLIED TO WINDING PULLEY

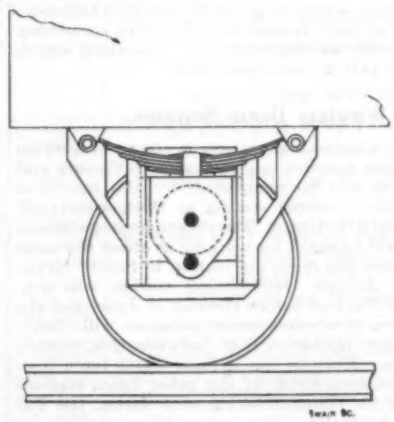

FIG. 6—ANTI-FRICTION WHEELS APPLIED TO RAILWAY TRUCK

It is interesting to compare the sensitiveness of the apparatus with that of a balance. The roller may be likened to an equal-armed balance beam only 1¼in. long; that is, having arms, each ⅝in. long, fitted with knife edges, and loaded with 11 oz. in each pan. Two grains added with extreme care to one of the pans of this hypothetical balance will perceptibly move the pointer. Such an instrument could be constructed, but only by a skilled workman. For an ordinary 9in. beam, arms 4½in. long, to equal this roller in sensitivity, an addition of 0·277 grain to its 11 oz. load pan or weight pan would have to yield a perceptible inclination of the pointer. This degree of sensitiveness is much better than the Board of Trade requires of a brass and agate class "B" beam.

In a modified form of the instrument used for demonstration purposes the weight of the rotor is 22,373·5 grains. The leverage of the weight pan over the periphery of the drum is in the

* Head of Research Department, W. and T. Avery, Ltd., Birmingham. These articles contain the substance of a paper read before the Midland Branch of the Institution of Mechanical Engineers, Birmingham, October 15th, 1925.

† No. II. appeared April 16th.

‡ "Proceedings," Inst. C.E., Vol. 119, page 46.

ratio of 40 to 3. A weight of 100 grains on the pan exerts a tangential force of 7·5 grains at the drum periphery. This gives $7{\cdot}5 \div 22{,}373{\cdot}5 = 0{\cdot}00033$, as the static coefficient of rolling friction. This figure for phosphor bronze rollers and rails is about ten times less than what has hitherto been supposed to be the coefficient.

These determinations indicate that even the finest ball and roller bearings are much less efficient than might perhaps have been expected had we not known the true coefficient. If we take 0·0015 as the actual coefficient of rolling friction of an average well-fitted, high-class ball or roller bearing, it will be seen that it is about eight times as great as the actual coefficient for a steel ball rolling on a steel race. It is to be observed that in all the author's experiments, only light loads were used, not exceeding about 3 lb. as a maximum for small balls up to ¼in. diameter, and for rollers $^{3}/_{16}$in. wide and 1¼in. diameter. There is some indication that in the case of phosphor bronze rollers, and of steel rollers not "glass-hard," a slight increase in the coefficient is experienced when loads of from 2¼ lb. to 3 lb. are exceeded. This point deserves investigation, but the author must necessarily for the present leave further work on the subject to other hands.

While ball bearings have proved on the whole very successful, except for very heavy loads, and certain special conditions—the author is still sceptical as to the commercial utility and reliability of the roller bearing for heavy duties. The matter must still be regarded as *sub judice*, but it may be suggested that the anti-friction wheel should be given a chance. There is room for anti-friction wheel bearings of the single-wheel and double-wheel type. For reasonable ratios the efficiency of the system is practically proportional to the ratio of spindle diameter to bearing wheel diameter. In Figs. 5 and 6 respectively such wheels applied to the winding pulleys of pits and to a railway truck are shown. The sketches are suggestions, and nothing more, and, of course, difficulties would be met with in design and in construction. If, however, a fraction of the skill, energy and money that have been expended on other types of bearings had been given to the development of the anti-friction wheel, we should, the author feels sure, have attained by now to some very useful applications.

Alternating-current Pressure Regulators.

No. II.*

WHILE the interconnection of power stations does not present great technical difficulties, it is not quite such a simple and straightforward matter as many seem to suppose, for it is not always merely a question of running a cable from one station to another and closing a switch. The proposal to interconnect stations on a more or less extensive scale has been under consideration in this country for a considerable time, and as everyone knows, it is one of the principal features of the present Electricity Supply Bill. As long ago as 1916, when the interconnection idea was almost as prevalent as it is now, Mr. J. S. Peck, of the Westinghouse Company—now the Metropolitan-Vickers Electrical Company—read a paper on the subject before the Institution of Electrical Engineers, and since that time experience has been gained in the manufacture of apparatus required to control the voltage and power factor of lines connecting power stations of the same frequency. Messrs. L. Romero and J. B. Palmer, of the Metropolitan-Vickers Electrical Company, have discussed in a later paper before the Institution of Electrical Engineers the factors to be considered when designing an interconnecting link between two alternating-current power stations, with particular reference to power factor and its control, and although we are not primarily concerned in these articles with interconnection problems, that part of the paper which deals with the use of induction regulators for interconnecting purposes is worthy of consideration.

It is a well-known fact that the division of load in any desired proportion between two alternating-current power stations depends wholly on the adjustment of the steam supply to the prime movers. The mere adjustment of the field strength of the generators or the raising by other means of the voltage at the sending end of the interconnector only causes wattless kilovolt-ampères to flow round the circuit formed by the generators at the two power stations and the interconnecting cable, the true kilowatts remaining unaltered, except for the load added by the copper loss in the interconnector. When current flows through a circuit having resistance and reactance, such as an interconnecting cable with or without step-up and step-down transformers, the voltage at the two ends of the circuit will differ either in magnitude or phase displacement, or both.

The diagram, Fig. 11, is a modification of the Kapp diagram for the pressure regulation of a circuit containing resistance and reactance. E_1 is the voltage at the receiving end of an interconnector; E_2 the voltage at the sending end; I Z the impedance drop in the line and transformers; I R the resistance drop; and I X the reactance drop. The angles φ_1 and φ_2 represent respectively the phase displacement of the voltages at the receiving and sending stations with respect to the current in the line. The impedance of the line and the accompanying voltage drop represented in the diagram by I Z causes the phase displacement between the two voltages. For a given load the position of the voltage triangle with respect to the current vector will vary with the value $(E_2 - E_1)$, which is the difference in magnitude of the station voltages. Since the cosines of the angles φ_2, φ_1 are the power factors of the load at the sending and receiving ends respectively, it will be clear that the power factor of transmission at one end of the line can be controlled and kept constant by varying the voltage of one station with respect to that of the other as the load varies.

There are three main conditions of voltage relationship under which power can be transmitted between two stations:—(1) When the station voltages are constant and equal, the mean power factor of transmission will remain at a constant leading value, the power factors at the station ends of the interconnector varying within small limits in opposite directions as the load varies or reverses in direction. (2) When the

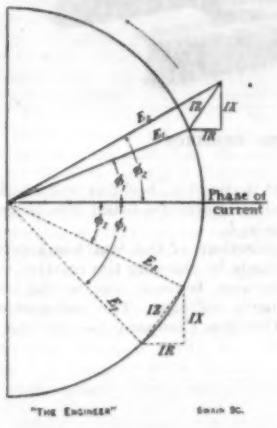

FIG. 11

station voltages are constant and unequal, the power factor of transmission will vary with the load in the direction of lag to lead as the load increases, and *vice versâ* as the load decreases, this method only being suitable for the transmission of power in one direction. (3) When the station voltages are varied by a booster or other means as the load varies the power factor may be kept constant at any desired value within the range of the voltage variation available. Under condition (1), power up to the capacity of the line may be transmitted in either direction without varying the voltage or mean power factor at all, and this condition is shown dotted in Fig. 11, where the two voltage vectors E_1 and E_2 are of equal length. Both these vectors lag behind the current vector of reference; in other words, the load in the interconnector is at a leading power factor throughout the length, the mean angle of lead depending upon the ratio of reactance to resistance in the circuit. For a given line the power factor of transmission at the two ends of the line will vary in opposite directions with the load, the mean power factor remaining constant. This method might be used for a line connecting two stations, each with a load at or near unity power factor, and where it is necessary to reverse at short notice the direction of transfer of power is the line. Under these conditions:—

$$\tan \alpha = \frac{R}{X}$$

where α is the mean angle of lead of the current, X the reactance of the line, and R its resistance. By making X as large as possible without detriment to the synchronising power, the mean power factor of transmission might in some cases be fairly near unity, and power could be transmitted under these conditions in either direction without any very serious interference with power factor values elsewhere. The majority of power stations are, however, unable to receive and absorb into their systems a bulk supply at a leading or even unity power factor without very serious disturbance to their operating conditions. Therefore, unless special measures are taken to supply the large wattless current which might be required, this method has a limited field of application. Method (2) is actually used with success in a number of cases, in which the load is only transmitted in one direction, the voltages usually being fixed to give the most desirable power factor of transmission at full load. Its advantage over the first method is that it is possible to transmit a fixed load at any desired constant power factor. It is, however, only suitable for one-way transmission, as a reversal of power would give rise to a low leading power factor. As the load varies the power factor of transmission varies within wide limits, and with a large voltage difference in the circuit it would scarcely be practical to work without a regulator of some sort for the purpose of reducing the voltage difference when switching into or out of parallel, for otherwise the sudden making or breaking of the large wattless current would have serious effects on the pressure at one or both of the stations. Where the difference in voltage has to be large, these considerations would appear to rule out a fixed voltage difference, although the method gives fairly good results under favourable conditions and where it is only necessary to transmit power in one direction.

In many cases the third method has to be adopted. The variation in pressure may be obtained by varying the bus-bar voltages at one or both stations, or by introducing a boost in the interconnecting line. In the case of most public undertakings, variation of the bus-bar pressure is not, of course, permissible, and the introduction of a boost into the interconnector is often essential. The boost may be given by induction regulators, static boosting transformers with step-by-step regulators, or by means of variable regulating tappings on the main transformers. Step-by-step and induction type regulators have been in use for many years, and in America a combination of the step-by-step and induction type regulator has been developed for the control of electric furnaces, and has been applied to some extent to the regulation of feeders. The boosting transformer has comparatively few tappings and the induction regulator is connected to the tappings successively by a system of transfer switches, with the result that fine voltage regulation is secured.

As explained in the previous article, in the three-phase induction regulator the secondary induced pressure is constant in magnitude, the variations in the resultant voltage being obtained by the alteration in the phase angle between the applied and induced voltages. As the phase displacement of the resultant voltage with respect to the current in the line is fixed by the difference in magnitude between the resultant voltage and the voltage at the receiving station, the phase of the applied voltage with respect to the receiver voltage is altered, when the resultant boost is less than the maximum, but the power factor of the sending station load carried by the interconnector is not altered because the phase of the line current is shifted by a similar amount, the losses being neglected. In Fig. 12, cos φ 2 *a* is the power factor in the line at the sending end at full load and full boost cos φ 2 *b* the power factor in the line at the sending end at half load and half boost, and cos φ 2 *c* the resultant power factor of the interconnector load on the sending station. D is the constant voltage added by the induction regulator. When more than two power stations are connected together, the phase angle introduced by the induction regulator may give rise to complications, and, as already explained, it is then desirable to wind the induction regulator with its series windings in two parts connected in reverse series, for in this way the resultant voltage is brought into phase with the applied voltage, as shown in Fig. 13. This matter is more fully dealt with in

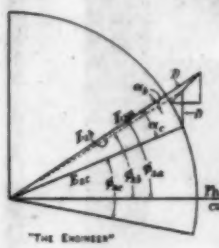

FIG. 12

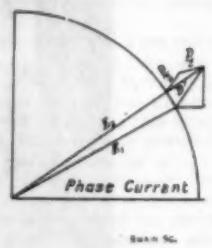

FIG. 13

Mr. Carr's paper, to which we have previously alluded. In interconnection schemes involving the transmission of large amounts of power over considerable distances, it is often desirable to place regulating plant at both ends of the line, each regulator providing half the total capacity required, for otherwise the voltage boost provided by the regulator might in some cases bring the resultant voltage to a value far above the normal transmission voltage.

An Oerlikon double-induction regulator for the automatic regulation of power factor is shown in Fig. 14. This regulator is designed to pass 12,000 kilovolt-ampères, the actual internal capacity of the regulator being 1870 kilovolt-ampères. Large-capacity induction regulators built by this firm are made, as a rule, for pressures up to 10,000 volts, whilst for higher voltages series and excitation transformers are employed. The rotor of the double regulator shown in Fig. 14 is fed through an excitation transformer, whilst the stator is coupled to the system through a series transformer. The plant is connected in the interconnecting line of two stations, and it is controlled automatically by a phase regulator. In discussing Messrs. Romero and Palmer's paper, Mr. P. V. Hunter very rightly pointed out that to provide a feeder at great expense for the sole purpose of carrying energy from one station to another was not as a rule desirable. The proper course, he argued, was to make the interconnector also act as a network feeder. The difficulty of transferring load from one power station to another is greatly reduced if the power station interconnector also supplies a sub-

* No. I. appeared April 16th.

stantial load somewhere along its length. The same view was expressed by Mr. J. M. Donaldson, and it was also endorsed by the authors. Two extreme cases may be defined as follows :—(1) The whole or the bulk of the load lies between the two power stations, and in this case the problems discussed would not arise, as the two stations would simply feed into the network, and would not interchange

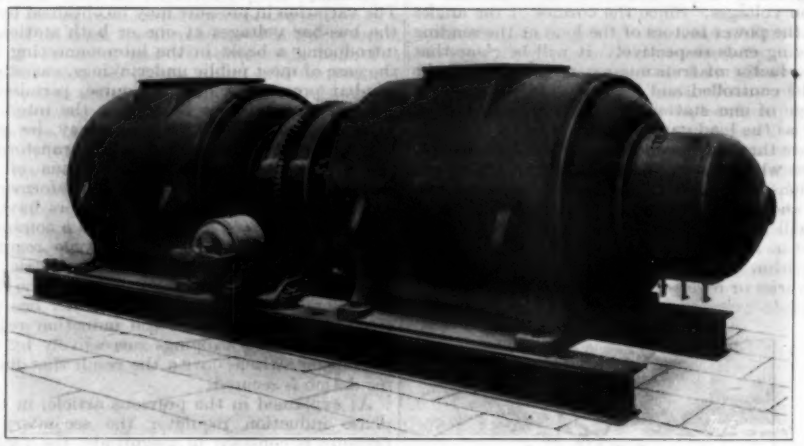

FIG. 14—DOUBLE-INDUCTION REGULATOR—OERLIKON

power at all. (2) The bulk of the load is situated in the two areas surrounding the two power stations, and a small load, relatively to the load transmitted between the two power stations, is tapped off the interconnector for isolated factories or villages *en route*. In this case the variation of voltage at points on the interconnector might be considerable when the direction of flow of power was reversed, and special steps

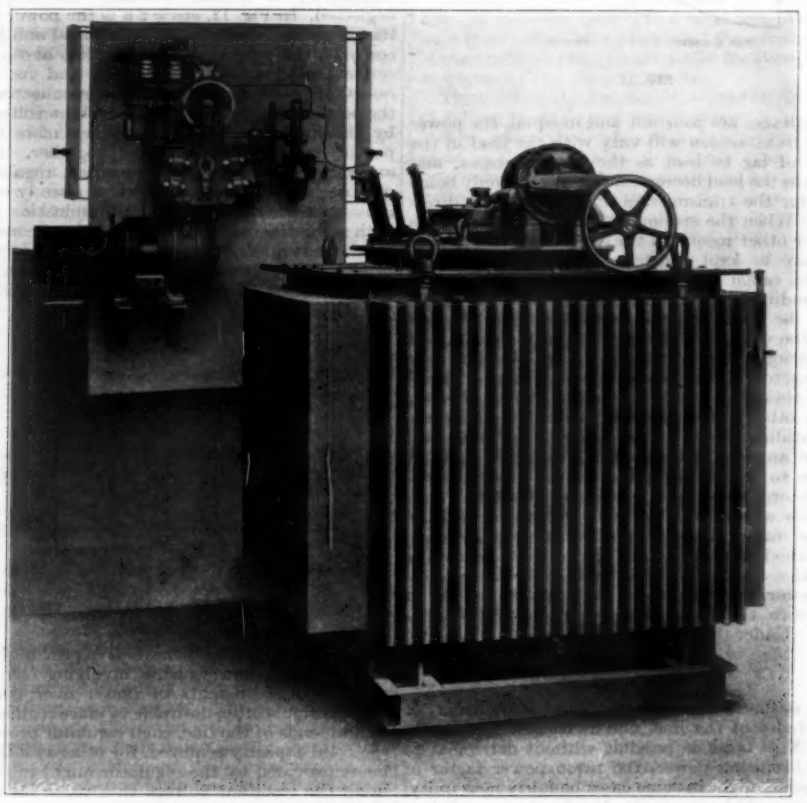

FIG. 15—AUTOMATICALLY-CONTROLLED POWER FACTOR REGULATOR—OERLIKON

might have to be taken to give the consumers a constant voltage. Between these two extreme cases there will obviously be a point where the interconnecting cable will cease to be a true interconnector for the transfer of power from one station to another in the sense discussed.

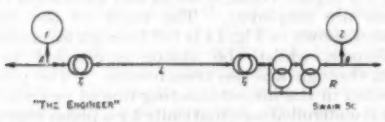

FIG. 16—TRANSMISSION LINE WITH INDUCTION REGULATOR

The Oerlikon Company has recently introduced an automatically controlled induction regulator, as shown in Fig. 15, for the regulation of power factor. In the diagram, Fig. 16, 1 and 2 are two power stations connected together by an interconnecting line L; T_1 and T_2 are transformers, and I R a double induction regulator. Let it be supposed that the power station 2 has to supply the power required by its own distribution system at a power factor of cos φ_2 b = 0·8, and at the same time draws a certain amount of energy from the power station 1 over the transmission line. As the energy received has a power factor differing from cos φ_2 b, the power station 2 cannot make use of it directly, but has to furnish the necessary kilovolt-ampères to bring the power factor to the true cos φ_2 b.

The distribution of the wattless kilovolt-ampères cannot be made by varying the relative values of the bus-bar pressures, because that would interfere with the consumer's voltage. The automatic apparatus which the Oerlikon Company has devised for regulating the wattless kilovolt-ampère load is shown in Fig. 17, where the induction regulator I R in Fig. 16 is shown at I. The regulator is connected at the point of junction of the interconnecting line with the power station 2, and it permits of regulation of the pressure at that point, independently of the bus-bar pressure of the power station and in such a way that the latter station does not have to supply additional wattless kilovolt-ampères at any load. The induction regulator works over its whole plus or minus range between light load and full load, and the regulation process follows the variations of load and bus-bar pressure, a correct distribution of the wattless load being obtained when the power factor of the energy supplied is maintained at a constant value. The regulator keeps the power factor constant quite independently of the variations in pressure or the fluctuations in current, and the direction in which the energy is transferred, but it can be adjusted for desired power factor without detriment to the sensitiveness of the apparatus. The actual operating gear consists of a Thury regulator which is too well known to need description. The balance beam W of the regulator carries two pressure coils E_1 and E_2 on opposite sides of the beam fulcrum L, and these coils are situated in the air gaps of two electro-

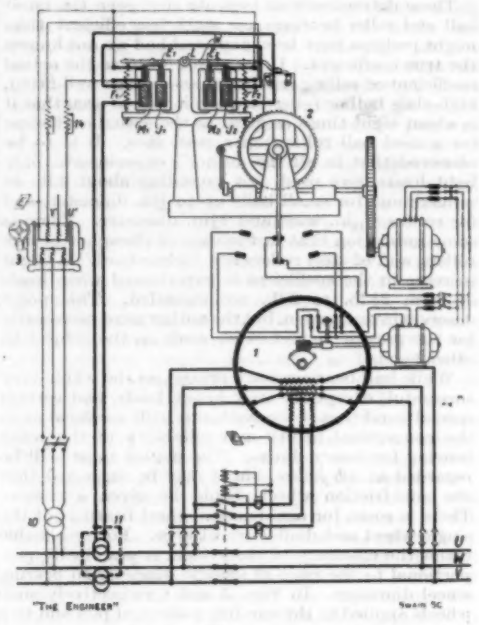

FIG. 17—REGULATOR CONNECTIONS—OERLIKON

magnets M_1 and M_2, which are excited by current coils J_1 and J_2. Springs F_1 and F_2 at the ends of the beam serve for setting the beam in a state of equilibrium. Other devices provided for damping purposes, &c., are not indicated on the diagram. The two current coils J_1 and J_2 are in series and are fed by a

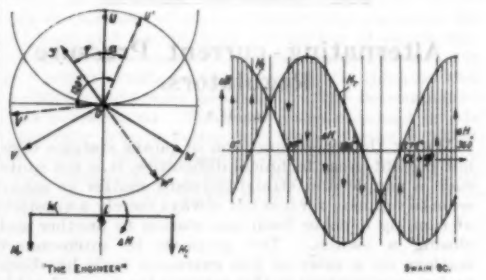

FIG. 18

current transformer 11 inserted in one phase of the system; whilst the two pressure coils E_1 and E_2 are connected across one of the stator phases of a small phase regulator 3 through adjustable resistances 14, this phase regulator being wound as an ordinary three-phase induction motor, with a capacity

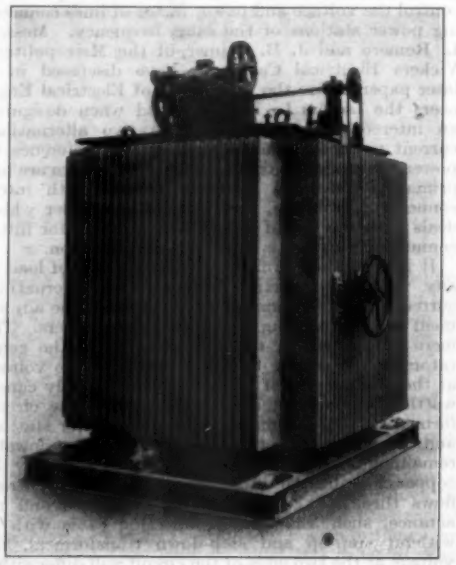

FIG. 19—10,000-VOLT INDUCTION REGULATOR—OERLIKON

of about 0.3 kilovolt-ampères. The rotor of the regulator can be displaced in relation to the stator by means of a hand wheel and worm gear, and it is fed by means of the three-phase potential transformer 10, connected to the system at the point where the power factor is to be kept constant. Let U,

V and W be the phase pressures of the supply, and U^1, V^1 and W^1 the induced pressures in the stator windings. These pressures can be represented, as in the diagram, Fig. 18, the phase displacement between the vectors U, V and W and the vectors U^1, V^1 and W^1 being dependent upon the

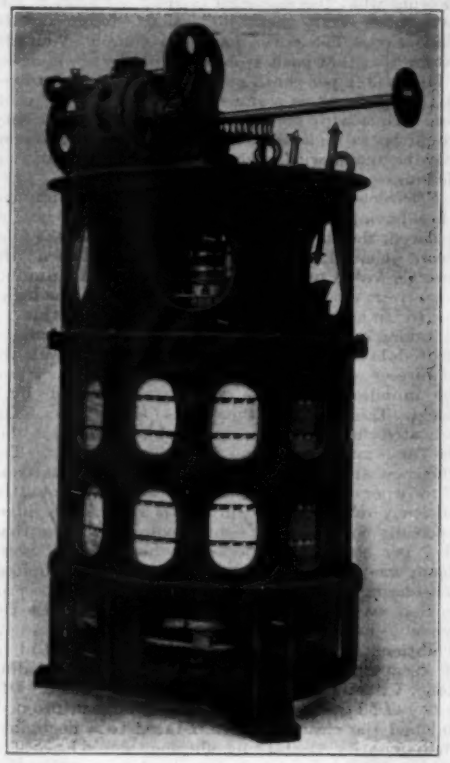

FIG. 20—INDUCTION REGULATOR REMOVED FROM CASE

position of the rotor in relation to the stator, which can be varied at will. Let it be supposed that the current transformer for the current coils is connected in the phase U Fig. 17, and that the current J has a phase displacement of φ, as shown in the diagram, Fig. 18. The forces acting on the balance beam W are due to

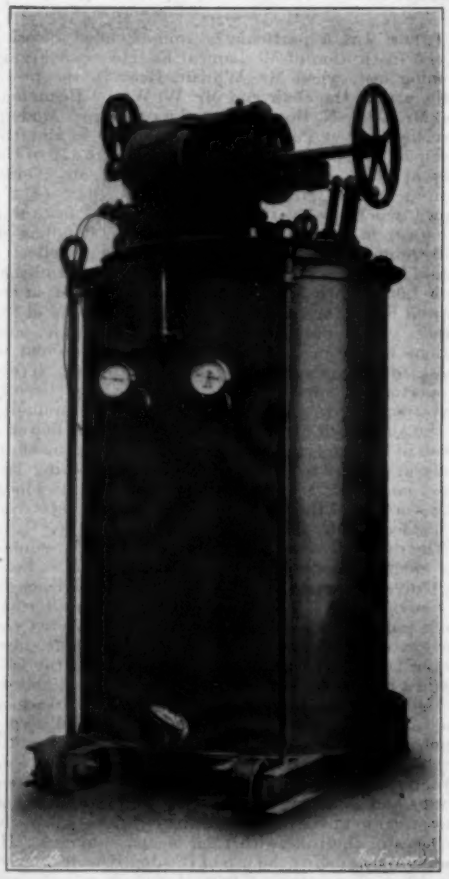

FIG. 21—WATER-COOLED INDUCTION REGULATOR—OERLIKON

the interaction of the currents I in the pressure coils E_1 and E_2, and the magnetic field across the gap of the magnets M_1 and M_2. The currents I are derived from the phases U^1 and V^1 of the phase regulator through resistances 14, which ensure coincidence of phase of these currents with the pressures U^1 and V^1. The field of the magnets M_1 and M_2 is produced by the current J flowing in the current coils J_1 and J_2, drawn from phase U of the system. Hence there are two forces applied at either end of the balance beam, and these forces may be represented by H_1 and H_r respectively. If these forces are unequal there is a resulting force $\Delta H = H_1 - H_r$, which causes the beam to leave its position of equilibrium. From the diagram Fig. 18, it will be seen that H_1 can be expressed as $J I \times \cos(\varphi + \alpha)$ and H_r as $J I \times \cos(120 \text{ deg.} - [\varphi + \alpha]) = -J I \times \cos(60 \text{ deg.} + \varphi + \alpha)$. The variation of the force ΔH as a function of the angle $(\varphi + \alpha)$ is represented on the right of Fig. 18, where it can be seen that ΔH has a value of 0 for $(\varphi + \alpha) = 60$ deg. and for $(\varphi + \alpha) = 240$ deg., consequently the balance beam can only attain a state of equilibrium when the phase displacement of the current J is = (60 deg. $- \alpha$) or (240 deg. $- \alpha$), and it follows that when the balance beam is in a position of equilibrium the current J lies along the line bisecting the angle between U^1 and V^1. The first position corresponds to the conditions of operation when energy is drawn from the distant station and the second when energy is supplied. A more detailed study of the question shows that in either case the state of equilibrium is stable under any variation in load or fluctuation in pressure, and the value of the phase angle between the pressure U^1 and V^1 has a considerable influence on the sensitiveness of the power factor regulator. The sensitiveness of the apparatus is, in fact, about 70 per cent. greater with a phase angle of 120 deg. than it is with a phase angle of 60 deg. The pressure and current can vary within the widest limits without affecting the adjustment of the power factor regulator, but the equipment can, on the other hand, be set for a different power factor merely by turning the phase regulator. The regulator can also be used with transformer tapping switches or for controlling a synchronous condenser.

An oil-immersed self-cooled 10,000-volt induction regulator, made by the Oerlikon Company for giving a $\pm$ 1250 boost is shown in Fig. 19; whilst Fig. 20 shows the regulator removed from its tank. An oil-immersed water-cooled regulator designed for 5350 $\pm$ 400 volts is shown in Fig. 21. This regulator is designed for passing 6200 kilovolt-ampères, its actual internal capacity being 560 kilovolt-ampères.

A Suggested Method of Obtaining Power from Sea Waves.

In a recent issue of *Le Génie Civil* there appeared an article, signed by Monsieur P. van Vloten, a Belgian engineer, in which he describes a new method of obtaining power from sea waves that he has devised.

In introducing his subject the author states that the many inventors who have studied this problem have failed for the following reasons:—(*a*) They have sought to obtain power *directly* from wave movements; (*b*) the power obtained has been small in proportion to the outlay, and the apparatus they have employed has, not infrequently, been demolished by storms; and (*c*) the places chosen have not afforded favourable conditions, although favourable conditions are to be found on about half the coasts of the world.

Broadly speaking, what Monsieur van Vloten proposes to do is to make the waves, as they reach the shore, run up an inclined surface, and flow over the crest of that surface into a channel-like reservoir formed at some height above mean sea level, and running the whole length of and parallel with the incline. The water so trapped is to be allowed to flow back into the sea through turbines coupled to electric generators. His idea is illustrated diagrammatically in the accompanying engraving. The

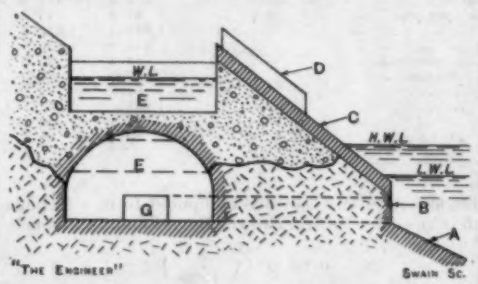

DIAGRAM ILLUSTRATING M. VAN VLOTEN'S PROPOSAL

inventor, in describing his scheme, points out that the upper part of a wave, or of a swell undulation, has a movement shorewards, while the lower part—presumably owing to the falling back of the preceding wave—has a motion seawards. It is, therefore, so as to obtain the best results, necessary to separate the top from the bottom portion. To do this he forms his structure so that at the bottom of the incline the wall is taken down vertically, as at B in the sketch, so as to form what he calls a *seuil de deferlement*. Shoreward from the foot of this wall the beach is made to slope gently seawards as at A, this being done to increase the effect of the wave as it reaches the obstruction by increasing its amplitude as it is propelled towards the shore.

Monsieur van Vloten states that, apparently, the best angle to give the slope C is between 35 deg. and 40 deg. with the horizontal, but that, in actual practice, it will be found most expedient to give it a slope of from 25 deg. to 35 deg. He proceeds to discuss the matter mathematically, but we need not follow him through his calculations. It will be sufficient to say that, according to him, the maximum force recoverable is directly proportional to the cube of the height of the wetted surface of the incline, that is to say, of the height up the incline to which the waves force themselves. It follows, he says, that optimum conditions for his system are obtained where the height of slope wetted by the water—or what comes to much the same thing, the actual height of the waves—is greatest, while at the same time as constant as possible, and where the difference in level between high and low water does not exceed 2 m., or, say, 6ft. 6in. In passing, it may be remarked, that round our own shores it would be a difficult matter to find points at which such conditions rule.

Proceeding, Monsieur van Vloten says that from figures he gives it may be deduced that the maximum force recoverable from the water lifted by the waves corresponds to a fall the height of which is one-third the height of the wetted surface of the incline, which would give an indication as to the best elevation at which to place the overflow sill at the top of the incline. This height, he continues, must obviously be chosen having regard to mid tide, for it is evident that, if there were no rise or fall of the tide at all, the supposed constant level of the sea surface would naturally be taken as the datum. Hence, where there are tides, the datum chosen would, as naturally, be the mean level of the sea which would correspond to half tide.

The channel into which the water flows when it reaches the top of the incline may, according to Monsieur van Vloten, be regarded as a sort of water fly-wheel, the office of which is to make up for the inevitable irregularities in the input of water from the various waves, so that the head of water on the turbines may be kept as even as possible. Its area should, therefore, be made as large as possible. The volume of its contents may be determined having regard to the following considerations: It is known that, in consequence of interference, which is always present in the neighbourhood of coasts, certain waves, while they may be at the same distance apart, are stronger or feebler than those which follow them. Taking a complete cycle to be composed of n waves with lengths equal to the length of the inclined surface, then he considers that, as a minimum, the channel should hold a volume of water at least equal to the input of five complete cycles, that is to say, of 5 n waves. This volume, it is remarked, may seem exaggerated, but it is better to make it large than small, so that the variations in the level of the water are kept as small as possible.

In the same way it is necessary—in order to avoid undue variations in the level of the water in the discharge basin E into which the water, after passing through the turbines flows—to give that basin a content and a water area as large as possible, and to provide a series of large openings G leading to the sea below the level of the lowest tide.

The inclined surface is only taken down a few decimetres below the level of low water, and it there joins the vertical surface or *seuil de deferlement* B, which is given a height of several metres. In order to prevent sideway movements of the waves and to guide them straight up the incline into the collecting channel, Monsieur van Vloten arranges partitioning projections D on the upper part of the surface of the incline. They are regularly spaced at a distance of several metres apart. It is proposed to make the collecting channel comparatively narrow and shallow at its two extremities, but gradually wider and deeper as the centre is approached, so that at that point there may be a deep basin or reservoir of large area, and it is there that the turbines and generators would be placed. To complete his installation Monsieur van Vloten proposes to arrange at some distance from, and parallel with the shore and the inclined plane, a series of floats securely connected to anchors, the object being to keep the wave crests from breaking and the water from becoming frothy.

Such, in brief outline, is Monsieur van Vloten's scheme for obtaining power from the waves, and he claims that by it he will be able to produce a kilowatt-hour for half the cost possible with a steam-driven plant of equal size. The idea is certainly ingenious, and with suitable conditions there does not seem to be any reason why it should not operate successfully, provided that troubles with silting up could be avoided. It would appear, however, that, especially during storms, silting up, which, even if only the *seuil de deferlement* were covered might seriously interfere with the working of the scheme, might easily occur. It seems to us, too, that the situations where the necessary conditions exist would be somewhat hard to find, in spite of Monsieur van Vloten's assertion that they exist on about half the coasts of the world, and that where they were found they might, and probably would, be in situations where electric power is not required.

Two empty passenger trains were in collision in the tunnel on the north side of Blackburn Station on Saturday afternoon last. Three trainmen were hurt.

Tests of a Back Pressure Steam Turbine.

AMONGST the builders of steam turbines on the Continent, few firms have done as much to develop the design and construction of such machines as Messrs. Brown, Boveri and Co., of Baden, Switzerland. Realising that the reaction principle was inherently the most efficient, they have demonstrated that with good design this superiority could be realised in practice, especially in the case of large machines, and they have established a reputation for building turbines of an efficiency second to none. Hence, every authoritative and detailed test of any of their machines is of great interest, and especially so when the machine is a little out of the ordinary. Such a test is described in an article by Monsieur M. Hentsch, published in *La Génie Civil* for March 6th last. It was carried out by Professor Stodola, of the Zürich Polytechnic, whose reputation is a sufficient guarantee as to the reliability of the results obtained. The turbine tested is quite a small one, having a rated capacity of 1000 kilowatts at 3000 revolutions per minute, and instead of being an ordinary condensing machine, it is built to work against a back pressure of 2·7 kilos., or 38·4 lb. per square inch absolute. It is of the disc and drum type, having one single-bladed impulse wheel followed by twenty-eight rows of reaction blading on a conical drum. The reaction blades are of brass with thinned tips, so that should contact accidentally take place when running, no harm would be done. The end thrust is balanced by a dummy piston, any excess being taken by a Michel thrust block. Labyrinth packing is used for the shaft. The steam inlet is controlled by three valves operated by oil under pressure. At normal full load two of these valves are open, giving full admission to the impulse wheel; under overloads the third valve opens admitting extra steam on the after side of the impulse wheel.

There is no need to describe the minute care taken with the calibration of the instruments, &c. Mention, however, may be made of the means adopted to determine bearing friction and oil pump power. To do this the steam pipe was blanked off, the turbine uncoupled, and connected to an electric motor. By allowing air to enter the turbine and keeping the air pump running, the turbine could be motored round at various vacua, any desired vacuum being maintained by adjusting the valve between the turbine and the condenser. It was found that with the turbine driven at constant speed, the power absorbed varied with the vacuum according to a straight line law. By extrapolation therefore it was easy to find the power which would be required with a perfect vacuum on the turbine. This was taken to be the power absorbed by friction on the bearings, governor gear, and oil pump with the turbine running under normal conditions.

Efficiency of the Reaction Blading.—To determine the efficiency of the reation part of the machine, the blades were taken out of the impulse wheel and the nozzles removed. Readings were then taken of the temperature and pressure of the steam, both before and after the reaction blading, each reading being made in two different places. The steam passing the dummy piston was condensed at atmospheric pressure and measured; that leaving the low-pressure gland was evacuated to the condenser; whilst that escaping by the gland vent pipes was considered negligible. Table I. gives the results of these tests. The efficiencies are computed on two bases, namely, on the total quantities of steam introduced into the turbine, and also on the quantity of steam actually passing through the blading, the latter being called in the table "useful steam." This figure has its importance, as it is, of course, possible to build turbines without dummies, thereby suppressing the dummy leakage. Dr. Stodola has determined the indicated efficiency for the useful steam in two different manners, according to whether the work done in driving the debladed impulse wheel, oil pump, governor gear, bearings, &c., was taken into account or not. The work done in driving the mechanical parts of the turbine was arrived at in the manner already mentioned, while that due to driving the unbladed impulse wheel was computed from a formula developed by Messrs. Brown, Boveri and Co., namely

$$N = 0{\cdot}08\ D^{4{\cdot}2}\left(\frac{n}{1000}\right)^{2{\cdot}8}\gamma\,;$$

in which N = the indicated power in kilowatts
D = the diameter of the wheel in metres.
n = speed of wheel in revolutions per minute.
γ = density of the steam in kilos./m³.

In M. Hentsch's article, a diagram is published giving the mean curve of the indicated efficiency corresponding to the figures in Table I. This efficiency reached a maximum of 88 per cent. The true hydraulic efficiency of the blading should be arrived at by taking into account the re-heat factor and the leaving losses, but these were both so small that the hydraulic efficiency could be taken as equal to the indicated efficiency without practical error.

The radial blade-tip clearance measured by lead wires, had an average value of 1·62 per cent. of the blade height, and 0·133 per cent. of the mean diameter. Messrs. Brown Boveri's practice is to allow a clearance equal to one-thousandth of the diameter for single-cylinder turbines and of eight ten-thousandths of the diameter for two or three-cylinder turbines, in which the bearing distances are relatively shorter. A curve is given in the diagram referred to showing what the indicated blading efficiency would have been were there no leakage losses at the blade tips. The curve has been computed on the assumption that each 1 per cent. of clearance causes a loss of 3·1 per cent., so that the actual clearance of 1·62 per cent. is assumed to involve a 5 per cent. loss. Thus with no clearance the blading efficiency would be as high as 93 per cent., and comparisons may be made with other turbines having different clearances on the assumption given.

Efficiency of the Complete Turbine.—The impulse wheel having been refitted with blades and the nozzles replaced, the turbine was tested as a whole, the inlet steam conditions being measured between the throttle valve and the inlet nozzles. The dummy losses were obtained separately as before. The losses due to fan action of the impulse wheel were estimated by taking a mean of the results given by the formulas of Stodola and Forner. Allowance was made for the conditions of partial admission and for the fact that the impulse wheel was partially surrounded by a shield. Table II. gives the results of these tests. The indicated efficiency of the reaction blading had sensibly the same value as during the preceding tests. The efficiency at the rim of the impulse wheel was from 77 to 79 per cent. As Monsieur Hentsch points out, the efficiency of the whole turbine is remarkably high, especially considering its small power. No less than 81·7 per cent. of the available heat of the useful steam was turned into work at the turbine coupling. Considering the steam used for all purposes, the proportion was about 80 per cent. In both cases the available heat in the steam was computed from its conditions at entry to the turbine nozzles and at its escape to the exhaust. The reaction blading alone, with its clearance of 0·73 mm., gave an efficiency of 88 per cent., as has already been mentioned, and had the clearance been reduced to a negligible, small quantity, the blading efficiency would have been as high as 93 per cent. It is to be regretted that this particular machine was not fitted with Parsons end-tightened blades, as it would then have probably been possible to approach the latter figure even more closely in the actual machine.

TABEL I.—*Tests of the Reaction Blading Alone.*

	Number of test	I.	II.	III.	IV.	V.	Ia.	IIa.
a	Absolute pressure at inlet to reaction blading, kilogrammes	6·5	6·3	7·8	6·7	5·3	6·6	6·5
b	Power developed at coupling, kilowatts	479	655	570	496	258	498	483
c	Losses in bearings, governor gear, oil pump and friction of impulse wheel, kilowatts	28	28	29	42	28	28	18
d	Indicated power of turbine (*b* + *c*), kilowatts	507	683	600	538	286	526	501
e	Adiabatic heat drop per kilogramme of steam calculated by Knoblauch's method, calories	41·9	55·3	41	42·4	32·1	42·8	41
f	Indicated heat drop per kilogramme of steam calculated by Knoblauch's method, calories	36·1	47·7	35·6	35·4	26·3	37·1	35·4
g	Theoretical power of useful steam, kilowatts	578	776	675	612	335	595	566
h	Theoretical power of total steam, kilowatts	598	803	699	634	347	617	588
i	Thermodynamic efficiency based on total steam (*b*/*h*), per cent.	80	81·6	81·6	78·3	74·4	80·6	82·2
j	Thermodynamic efficiency based on useful steam (*b*/*g*), per cent.	82·8	84·4	84·5	81·1	77·2	83·5	85·3
k	Indicated efficiency of useful steam calculated from heat drop (*f*/*e*), per cent.	86·1	86·2	86·6	83·5	81·9	86·9	86·2
	Indicated efficiency of useful steam calculated from power developed (*d*/*g*), per cent.	87·6	88	88·7	87·9	85·5	88·2	88·5

TABLE II.—*Tests of Complete Turbine.*

	Number of test	VI.	VII.
a	Mean absolute pressure before nozzles, kilogrammes	9·8	10·8
b	Mean temperature before nozzles, deg. Cent.	279	285·5
c	Absolute pressure in the impulse wheel chamber, kilogrammes	7·63	8·4
d	Temperature in the impulse wheel chamber, deg. Cent.	255	260
e	Absolute pressure at exhaust, kilogrammes	2·8	2·77
f	Temperature at exhaust, deg. Cent.	153·5	150·2
g	Weight of steam per hour through reaction blading (useful steam), kilogrammes	13,608	14,965
h	Weight of steam passing the dummy piston per hour, kilogrammes	435	521
i	Efficiency of the electrical generator, per cent.	94	93·6
j	Power developed at turbine coupling, kilowatts	841·5	1,010·8
k	Steam consumption per kilowatt-hour at coupling, kilogrammes	16·7	15·3
l	Losses (bearings, governor, oil pump), kilowatts	22·8	22·8
m	Disc friction and fan action of impulse wheel, kilowatts	12·6	13·7
n	Indicated power developed (*j* + *l*), kilowatts	864·3	1,033·6
o	Adiabatic heat drop across impulse wheel, per kilogramme steam, calories	14·6	15·0
p	Indicated heat drop across impulse wheel per kilogramme steam, calories	10·4	11·1
q	Theoretical power of impulse wheel (total steam), kilowatts	239	270
r	Indicated power of impulse wheel (total steam), kilowatts	171	200
s	Power at rim of impulse wheel (total steam), (*r* + *m*), kilowatts	183·6	213·7
t	Indicated efficiency, impulse wheel (*r*/*q*), per cent.	71·5	74·1
u	Efficiency of blading of impulse wheel (*s*/*q*), per cent.	77	79·2
v	Adiabatic heat drop across reaction blading per kilogramme steam, calories	50·7	55·5
w	Indicated heat drop across reaction blading per kilogramme steam, calories	44·7	48·1
x	Theoretical power in reaction blading (useful steam), kilowatts	803·3	967·3
y	Indicated power in reaction blading (useful steam), kilowatts	707·6	837·6
z	Indicated efficiency of reaction blading (useful steam) (*y*/*z*), per cent.	87·9	86·6
A	Theoretical total power (useful steam) (*q* + *x*), kilowatts	1,042·3	1,237·3
B	Indicated total power (useful steam) (*r* + *y*), kilowatts	878·6	1,037·6
C	Indicated efficiency based on heat drop (useful steam) (B/A), per cent.	84·3	83·9
D	Indicated efficiency based on power (useful steam) (*n*/A), per cent.	82·9	83·5
E	Total adiabatic heat drop per kilogramme of steam, calories	64·8	69·77
F	Theoretical total power (total steam), kilowatts	1,058	1,257
G	Thermodynamic efficiency (total steam) (*j*/F), per cent.	79·5	80·4
H	Thermodynamic efficiency (useful steam) (*j*/A), per cent.	80·7	81·7

Institution of Mechanical Engineers.

THERE was a particularly well-attended meeting of the Institution of Mechanical Engineers on Friday evening last, when Mr. William Reavell, the president, was in the chair and Mr. W. Worby Beaumont and Mr. Leslie N. Burt presented a paper on "Modern Development of Paper Mill Plant." We reprint the first part of it in an abridged form on page 476 of the present issue. In introducing the subject, Mr. Worby Beaumont laid stress upon those portions of the paper which deal with heat economy and instanced the great importance of labour cost and handling in mill design and operation. Any economies effected would be considerable when it was borne in mind that over 1,000,000 tons of paper were used per year in the United Kingdom alone. As regards the drying of the paper, it was necessary to point out that the conditions in the machine-room did not correspond to those of the laboratory experiment, in which the properties of vapour over still water was usually investigated. In the running machine the humidity of the air was all important. Mr. Burt then showed a series of lantern slides illustrating first an old machine built in 1810, which, he believed, was working last year, and later, various types of modern machines. The working of the Ogden-Minton vacuum dryer was explained by Mr. Burt.

The discussion was opened by Mr. W. H. Salmon, the chief engineer of the Imperial Paper Mills, Ltd., at Gravesend, who said that his own experience of the engineering side of the paper-making trade went back some fifty years, and he well remembered the early work of Bryan Donkin and George Tidcombe. Bryan Donkin's work was very accurate and the firm made a practice of stamping on the rolls the diameter to the third place of decimals. The material of which the early paper machines was built was usually very good, and, if he remembered rightly, there was still a mill in use in Buckinghamshire which was constructed over one hundred years ago. On one occasion rioters had sought to destroy that mill, but they had succeeded in doing little more than bruise some of the surfaces of the rolls with their sledge hammers. He clearly remembered the use of the Jog Knotter, which consisted of a series of bars threaded on rods and spaced by washers. In the early days felts were cleaned by beating them with sticks, and there was no felt cleaning machine. Difficulties were then often met with at the dry end of the machine, which were caused by frictional electricity, but the later introduction of cold cylinders had overcome such troubles. In the finishing process the method of plate glazing by pressing the paper between sheets of copper had

been introduced, and calenders were now employed to flatten the paper, after which it was super calendered when necessary. He was in full agreement with all the authors had said concerning the electric drive when it was necessary to keep eight or nine sections of a machine all in unison, and to take fully into account the variations of speed of the different cylinders, so that the drying of the paper did not lead to stresses in it as it passed over the drying cylinders, then the electric drive was undoubtedly the best. It, however, required a special site for the mill if a good lay-out was to be obtained. Electrically driven machines could not well be mixed up with old machinery. The electric current required would, of course, be generated by pass-out steam turbines.

Mr. W. Hunt, the chief engineer of the Empire Paper Mills, Greenhithe, Kent, the next speaker, said he would not like the meeting to get the idea that in a paper mill power was required for the paper machines. The preparing plant required up to two and a-half times the power which was needed for driving the machines. With regard to the steam, it was necessary to provide 3 lb. of steam at 10 lb. per square inch pressure for drying each pound of paper and 6¼ lb. per pound of paper for preparing the stuff. It would be seen that the total amount of steam used by a 900 to 1000 tons per week plant was considerable. In the ideal lay-out the power plant should be of such a size that it would provide that amount of steam on the extraction principle. As to the shrinkage of the paper between the wet and the dry ends of the machine a figure of 8 per cent. for newsprint might be taken, from which it would be seen that there was a considerable difference in the cylinder speeds.

Increased competition, said Mr. Hunt, had meant the introduction of higher working speeds, and we had now passed beyond the use of belt and rope drives and sectional driving had to be considered. With the electric motor the difficulty had been surmounted in a satisfactory manner. The variation in speed must not exceed 0·75 of 1 per cent. or stretch in the paper would take place between the wet and dry ends. Mr. Hunt then gave some figures for tests made with the B.T.H. alternating-current electric drive by stroboscopic methods. To the constant torque motor running at 100 per cent. load an increase of load of 14 per cent. was made, which gave a transient speed variation of only 0·0042 of 1 per cent. The load was then decreased 10 per cent., which gave a transient speed variation of ·0083 of 1 per cent. With the motor running at 88 per cent. of the full load an increase of load of 23 per cent. was made, the special speed control motor generators being out of action. Under such conditions a permanent speed variation of ·0014 of 1 per cent. was obtained, whilst when the load was decreased 15 per cent. there was a converse permanent speed variation of the same amount. With the electric drive the transmission losses between the engine and the actual sections of the machine were done away with.

Mr. C. Humphrey Wingfield suggested that the question of vapour pressures and temperatures should be looked into, and he advocated the use of low-pressure superheated steam for drying purposes.

Mr. J. d'A. Clark made reference to the use of suction press rolls and contended that the use of such rolls, if properly applied, did not give more "brake" in the making of paper. As to the disadvantage of the suction press roll marking the sheet, he suggested that that defect could be overcome by using a finer felt. He further stated that in America a roll with an ultimate pressure of 200 lb. per linear inch had been put to work, and that the results were favourable when compared with pressures of about 70 lb. With a careful application of the principles of drying and pressing the steam used could be reduced in a ratio of from 3 to 2. With regard to the effect of temperature on the drying felts, good results had been obtained by fitting a duck covering with a ¼in. asbestos felt on the top. He had shared the doubt of the authors as to the ease with which the paper might be fed through the Ogden-Minton dryer after a break, but he had seen a postcard pass through the machine easily, the vacuum directing it in its proper course through the rolls. With the Ogden-Minton method it was possible to dry the paper with 1·7 lb. to 1·8 lb. of steam per pound of paper made, which was considerably below the usual figure of 3 lb. to 4 lb.

Mr. Alexander Dow, of Detroit, who spoke at the request of Mr. W. H. Patchell, gave an account of the power supply conditions in an American territory of over 4000 square miles, in which he was interested. It included a group of paper mills engaged in the cover paper and strawboard industries. Mr. Dow stated that owing to the scarcity of the cheaper qualities of packing-box wood in America the use of paper and cardboard cartons had greatly increased. The great rush of business in the early days of that new industry had compelled the paper mill owners to approach the supply companies for alternating-current power supply, which they found gave good outputs with close speed regulation. Now upwards of 20,000,000 kilowatt-hours per annum of current were used in the mills. Recently, however, increased competition in the carton trade had caused the American paper mill owners to look into their heat balances and to study the economies which they thought might possibly be obtained by putting in their own power plant and using extraction steam for heating. The power company's engineers were engaged in going into the matter with paper mill owners, and it was not yet decided whether they would continue to buy power or to generate it themselves. This development had taken place because the United States could not afford to use its wood wastefully.

Major E. G. Beaumont suggested that there was no inherent advantage in combining the power and heating plant except when the steam engine was used. The authors had stated that the steam engine might be looked upon as a benevolent obstruction in the steam pipe, but he would rather speak of it as a commercial obstruction charging a high rate of interest. It was necessary even in the face of the users' negligent attitude towards the use of exhaust steam to study economy at both ends of the process. If heat was used unnecessarily at the power end, then the efficiency of the drying end was also spoiled. He was of the opinion that the use of the steam engine conferred no particular advantage, and it was incumbent on the designer to use the cheapest form of power plant so that the maximum economy might be obtained.

Mr. Loughnan Pendred, referring to Mr. Dow's remarks, recalled the fact that for the Sunday edition of one American paper no less than 100 acres of forest, equal in extent to the area of St. James's Park, were required to provide the pulp from which the paper used was made.

Mr. Dow reminded the meeting that most of the paper pulp came from the northern side of the border.

Mr. C. S. B. Marshall said that no mention had been made by the authors of the amount of paper that could be manufactured for the expenditure of one ton of coal. He believed that the American slogan was "ton for ton." It was certain that fine paper required more coal per ton than did the coarser qualities. The electrical drive was a beautiful thing, but it was extremely difficult to fit it to existing paper machines; moreover its cost was prohibitive. The cone belt drive continued to answer quite well for the slow-running machines. Mr. Hunt had said that the ratio between the steam required for the preparing process and that which was required for machine power was about 2½ : 1. Probably that was true for newsprint, but he—Mr. Marshall—was of opinion that the ratio was nearer 4 : 1 in the case of some of the bigger machines. Reference had been made by previous speakers to the steam pressures used in the drying process. He could say that they varied from quite low pressures for thin paper to a pressure of 15 lb. to 25 lb. per square inch for thick boards.

Mr. Worby Beaumont, in replying for the authors, said he was particularly interested in Mr. Salmon's reminiscences and he could not help feeling that in those early days, when so much experimenting was needed to get at a process, the work was much more interesting than it was to-day, when everyone knew so much. The questions of vapour pressure and temperature were important, and he would advise Mr. Wingfield to pursue his investigations. Mr. Dow had spoken of paper mill power supply conditions in America. The difficulty of continuing the power supply even in the face of competition might be got over by the employment of cheap electricity for steam raising in electric boilers. In Germany and South America, where electrical energy was produced by water power schemes, electric boilers were found to pay. The current was sold very cheaply indeed, and during the night load it was supplied at a rate of about 13 units for a penny. Replying to Major Beaumont's question as to steam power matters and the relative advantages of steam used for heating when raised in low-pressure boilers and that used from high-pressure power engines, he thought the answer was to be found in the paper itself. As he understood it, the question of the selection of the power engine and the steam pressure at which it should operate could not be decided without taking into account the whole of the requirements and the mill arrangement.

In closing the meeting and thanking the authors, Mr. William Reavell, the president, said that the paper was a clear illustration of the great advance which had been made in the paper industry. The speed of the older machines had been enormously increased in the modern machine, with larger widths and reduced costs. There was no doubt that the rapidity of development in paper-making was due to the application of the modern knowledge of engineering.

The Tailless Aeroplane.

In spite of all the aeronautical developments of the past fifteen or sixteen years, the aeroplane of to-day remains organically identical with the machines of the Wright brothers' era. That any form of heavier-than-air machine other than the orthodox aeroplane type is practicable is to many people scarcely credible. The all but complete failure of the helicopter has no doubt encouraged the belief that the aeroplane as we know it to-day provides the only reasonable means of mechanical flight. Occasionally news has been received that suggested that this belief was not well founded. Last autumn the Cierva "Autogiro" did much to disabuse the public mind in this respect. Once again we are likely to have the same lesson impressed upon us. Captain G. T. R. Hill has now produced the "Pterodactyl," a tailless aeroplane showing marked departures from standardised aircraft design, and has already gone so far as to satisfy the Aeronautical Research Committee that the ideas embodied in it are worthy of close study and development.

Captain Hill's proposals, the result of close consideration paid to loss of control in the air, were submitted to the Committee in the spring of 1923. With the assistance of the Committee, the Royal Aircraft Establishment and the Air Ministry he proceeded to give effect to his ideas in the form of a glider. The machine was tested in a remote spot in the South Downs in December, 1924. The results achieved were satisfactory to a degree beyond the inventor's dreams. Further official assistance was offered to him and a tailless machine fitted with a Bristol "Cherub" engine—nominally of about 30 horse-power—was produced. The first flight on this machine was made at Farnborough on November 2nd, 1925. Since then twenty-one flights in all have been made with it, and as a result much interesting and valuable information concerning its characteristics and capabilities has been obtained. Yesterday (Thursday) Captain Hill disclosed the results of his investigations for the first time in public in a paper which he presented before the Royal Aeronautical Society.

Into the theoretical considerations behind Captain Hill's invention we do not propose to go. It will be sufficient for the present to indicate their main bearing and to describe briefly the design of machine to which they have given rise.

The conventional aeroplane has three sets of control organs: the ailerons, the rudder, and the elevators. These elements when operated cause the machine respectively to bank, to yaw, and to pitch. In straight flight each set of organs no doubt exercises its proper function independently of the others. In manœuvring and on other occasions, however, they may each to a varying extent assume some part of the functions of the others and neglect their own. Moreover, in addition to providing the means of controlling the machine, the organs even in normal flight have to exercise their functions merely to preserve the trim of the machine. By so much as these trimming requirements absorb the controlability otherwise obtainable from the organs by so much will the manœuvrability of the machine be reduced. In straight flight at normal speeds the percentage of the controlability absorbed in maintaining the trim is small in a well-designed machine. But as the speed is reduced and the angle of incidence is increased the whole function of the elevators gradually becomes absorbed in preserving the trim, the ailerons increasingly assume the function of and oppose the rudder, and the rudder itself becomes less and less effective to manœuvre the machine. In brief, while the controls of a normal type of aeroplane are adequate so long as the stalling angle is not approached, they all become ineffective in stalled flight, and in addition serious lateral instability develops.

Investigating the problem, Captain Hill was led to the belief that its solution would be found in a wing having a stationary centre of pressure, as distinct from the normal wing, which has a large movement of the centre of pressure as the incidence varies. In the design of power-driven machine produced during the summer of 1925 the wings are swept back 31 deg. at the leading edge and 14 deg. at the trailing edge and are reflexed upwards at the trailing edge at all points by an amount equal to 0·015 of the chords. The incidence of the wings is washed out progressively towards the tips, the washout amounting to 3 deg. at the strut attachment and increasing by a further 3 deg. to the tip. There is no dihedral angle. Movable extensions fitted with balance weights on forwardly projecting arms are fitted to the tips of the wings. These extensions or controllers, when operated simultaneously, act as elevators, and when operated differentially as ailerons. A variable gear ratio is employed between the control stick and the controllers, which gives a low gear when the speed of flying is high and a high gear at low speeds.

Vertical surfaces serving as rudders are mounted at the extremities of the fixed part of the wing on its rear spar. Directional steering is obtained by operating the rudders separately. When the two rudders are operated simultaneously they act as air brakes. An arrangement is provided which ensures that when the two surfaces are in use as an air brake the rudder control is not lost. This arrangement is such that when the air brake is off and the pilot wants to turn to, say, port, a push on the rudder bar with his left foot operates the port rudder and leaves the starboard rudder trailing. With the air brake on the same action reduces the angle of the starboard rudder without materially altering the angle of the port rudder.

Since the large bending moments produced by the tail plane and the tail skid in the normal aeroplane are absent in this machine the body can be made very light. In the "Pterodactyl" the body is composed of a special light balsa plywood weighing only half as much as the ordinary birch plywood. The engine mounting is formed of four steel tubes braced with tie rods and weighs only 3½ lb.

The chassis consists of a front undercarriage with two wheels on a common axle and two legs anchored to the body with shock absorbers and braced by four

wires, together with a rear undercarriage composed of a single metal wheel in a fork. The rear wheel is connected to the rudder bar so that the machine may be steered on the ground, and in addition the wheel may be locked so that it may serve as a brake when landing.

In place of the usual tail-adjusting gear a spring device is fitted which can be set to provide any desired force on the control stick varying from + 15 lb. to − 15 lb. The gear weighs only 5 lb. and is fitted with a patented constant force spring which provides the same reaction whatever may be the position of the stick.

Full details of the features brought out by the tests of the machine are to be found in Captain Hill's paper. Summarising them, we may say that with a total load of 658 lb., representing a wing loading of 2·95 lb. per square foot, the speed reached was 70 miles an hour. The stalling speed is in the neighbourhood of 29 miles an hour. The machine is longitudinally and laterally stable at all speeds. If the control stick when the machine is side-slipping is released it immediately returns to the central position and the machine assumes a level keel. When flown in the stalled condition the machine remains under good control and can be transferred to the unstalled condition by gradually easing the stick forward and without causing the machine to dive to gain speed.

Each of the control organs does its own work and does not interfere with any of the others, and in general the machine is always under good control up to incidences as large as 45 deg. Captain Hill therefore seems justified in believing that he has attained, without loss of performance, the objective which three years ago he set out to reach.

The Mineral Production of New South Wales in 1925.

His Majesty's Trade Commissioner at Sydney, Mr. A. Simpson, has forwarded to the Department of Overseas Trade the following statement issued by the Under-Secretary for Mines, showing the mineral production of the State of New South Wales during the year 1925 :—

The value of the output of minerals for the year was £19,108,991, and it constituted a record, being £485,903 in excess of the value recorded for 1924, which was previously the best year. The value of the output given does not include that of clays, road metal, building stone, &c., obtained from the various quarries operating in the State, which would have increased the total by a further £709,512. The augmented production of silver-lead and Portland cement was mainly responsible for the increase in value of the yield for the year. The aggregate value of all minerals won in the State to the end of 1925 was a little over 404 millions. During the year the mining industry gave employment to 33,614 persons in and about the mines, exclusive of quarries, or an increase of 430 as compared with 1924.

Coal and Coke.

The quantity of coal won during 1925 was 11,396,199 tons, valued at the pit mouth at £9,302,515. The highest output was in 1924 when 11,618,216 tons of coal, valued at £9,589,547 at the pit mouth, were obtained. The output for 1925, whilst slightly below that of the preceding year, greatly exceeds the average output, and a fresh record would probably have been constituted but for the recent shipping trouble. The total production of coal in the State to the end of 1925 was 311,149,980 tons, valued at £150,953,909. The coal-mining industry afforded employment to 24,029 men, as compared with 23,024 during the previous year. The production of metallurgical coke was 609,418 tons, valued at £942,448, and was slightly in excess of the production for the previous year.

Silver, Lead and Zinc.

The value of the output accruing to the State of silver, lead and zinc amounted to £6,342,992 for 1925, and it represented the substantial increase of £736,061 in value, as compared with the previous year. The treatment of the ores and concentrates is carried on in other States, and the value accruing to the Commonwealth of the products of the silver-lead mines of New South Wales is set down at no less a sum than £8,910,313—exclusive of cadmium and copper, valued at over £65,000. At Broken Hill the quantity of ore raised amounted to 1,265,977 tons, or an increase of 215,303 tons as compared with 1924, and employment was found for an average of 5601 men, as against 5238 men during the previous year. Operations on the Yerrandenie field were retarded during the year owing to industrial trouble, and the value of the output only amounted to £27,603. The aggregate value of silver, lead and zinc produced in the State to the end of 1925 was £123,110,425.

Tin.

Tin mining was stimulated by the satisfactory price of the metal throughout the year, and a good water supply in the New England district, which enabled the dredgers to work continuously. The principal sources of stream tin, viz., the Tingha and Emmaville Divisions, produced £77,542 and £62,590 respectively. The returns from the Ardlethan and Torrington Divisions, the principal lode mining districts, were also very satisfactory, the values of the productions being £51,611 and £15,520 respectively. The production of metallic tin for 1925 was valued at £250,944, as against £250,485 for the previous year. The total value of the output of tin and tin ore obtained in the State to the end of 1925 was £13,351,664.

Copper.

The position with regard to copper mining in New South Wales is not very bright, and until the metal greatly appreciates in value no marked increase in the production of this State can be looked for. The yield for the year amounted to 478 tons of electrolytic copper, valued at £30,215. As in 1924, a large percentage was won by recovering the small copper content from the Broken Hill silver-lead ores. The total output of copper to the end of 1925 is valued at £15,517,826

Limestone.

The output of Portland cement for 1925 reached 304,089 tons, valued at £1,320,698, and was the highest yet recorded, being an increase of 31,789 tons and £120,698 in value, as compared with the cement manufactured during 1924. The whole of the production was obtained by three companies operating at Portland, Kandos, and Cockel Creek. It is expected that further rapid expansion of this section of the mining industry will take place, as two other companies are carrying out development and construction work, and preliminary investigations are being made by several other interests. Lime to the value of £96,178 was produced, being a slight increase as compared with the previous year, and the production of limestone flux was greater than in 1924, the output amounting to 135,115 tons.

Ironstone.

The production of pig iron from New South Wales ores was 95,530 tons, valued at over £500,000, as compared with 74,075 tons produced during 1924. The ore supplies of the largest smelting works are drawn from outside the State. The output of iron oxide, used for pigments and gas-purifying purposes, was 4376 tons, valued at £2436. The total value of the output of this branch of the industry to the end of 1925 was £7,525,632.

Gold.

The yield for the year amounted to 19,422 oz. fine, valued at £82,498, which represents an increase of £3128 in value as compared with the previous year. About half the production for the year was won by dredgers operating in the Adelong and Gundagai Divisions. The total value of the gold production of the State to the end of 1925 was £63,422,308.

Other Minerals.

The value of the output of other minerals is as follows :—

	£
Alunite	2,124
Antimony	395
Arsenic	8,333
Bismuth	2,950
Chrome	2,670
Diamonds	240
Dolomite	3,528
Magnesite	12,832
Manganese	3,635
Molybdenite	1,648
Precious opal	10,030
Platinum	11,061
Silica	11,847
Wolfram	311
Sundry minerals	107,269

Quarries.

During the year information was also collected respecting the production of clays, road metal and building stone from all quarries operating in New South Wales. The values of same were :—

Clays—	£
Brick and pottery clay	390,510
Fire-clay	6,081
Whiteclay	3,793
Road metal	251,956
Building stone	147,172

The aggregate value of the material obtained from these quarries amounted to £709,512, and 3623 men were employed.

New Electrical Show-rooms and Offices.

A large and very elaborate new building has been acquired by the Metropolitan-Vickers Electrical Company at 145, Charing Cross-road, where in future a considerable part of the London staff, including the erection staff, will be stationed. The headquarters and administration staff, together with the traction bureau of the firm and the whole staff of the Metropolitan-Vickers Electrical Export Company, will, however, remain at 4, Central-buildings, Westminster, which, of course, are the company's registered offices.

There is now a marked tendency in London for the various industries and professions to congregate in particular areas, and by opening this new establishment in Charing Cross-road the Metropolitan-Vickers Electrical Company has followed this practice, for in this locality there is a very fair number of firms which supply electrical goods of various descriptions. The tendency to centralise the offices and showrooms of electrical firms is obviously an advantage to electrical contractors, who can now send a messenger to Charing Cross-road with the knowledge that he will return with the particular article required.

The new building, known as "Metro-Vick" House, is situated about 100 yards from the junction of Charing Cross-road with Oxford-street, and its tower and flashing illuminated signs will be a conspicuous feature of the neighbourhood. Although it probably makes very little difference to the customers of the Metropolitan-Vickers Electrical Company whether the firm's London establishment is in Charing Cross-road or at Westminster, the position in the case of Metro-Vick Supplies, Ltd., which sells to the trade, is different. Every endeavour has been made to ensure a prompt and otherwise efficient service and to assist contractors in connection with lighting and other problems. Excellent storage accommodation has been provided and there are very elaborate showrooms in which all kinds of electrical fittings, domestic appliances, wireless goods, &c., are displayed. There is also an illuminating engineering department, a writing room with stenographic service for the company's trade customers, and ground floor windows fitted with the most modern arrangements for shop window lighting and display

The premises are on the site formerly occupied by Cross and Blackwell, Ltd., but the buildings of that firm have been entirely reconstructed; only the shell being retained. There are a basement, ground floor, and four storeys above, and the accommodation has been planned to ensure ease and accessibility between the various departments and stores. The building will serve for the London district office staff and the London erection staff of the Metropolitan-Vickers Electrical Company, the head office management and executive staff of Metro-Vick Supplies, Ltd., and the London office staff of that company.

The building was transformed into its present form by Foster and Dicksee, Ltd., of Rugby and Chelsea. The whole of the interior of the original building was removed and replaced by a modern steel work structure supplied by the Astor Engineering Company. Deispeker patented hollow tile fireproof flooring has been employed and Docker Brothers supplied the covering, which consists of Indorleum patented jointless flooring. The same firm also supplied all the paint and distemper for the internal decoration of the building. The internal metal work, such as door furniture and the special name plate at the entrance was undertaken by the Metropolitan-Vickers Electrical Company's subsidiary company, Harcourts, Ltd., of Birmingham. All the wiring and lighting arrangements, including the coloured effects for the display windows was carried out by the Engineering Works (Electrical and General), Ltd., under the supervision of the Illuminating Engineering Department of Metro-Vick Supplies, Ltd.

The special facilities offered at this new and elaborate establishment have been provided exclusively for the benefit of the electrical trade. Introductory tickets of admission to the showrooms and demonstration rooms are available on request, and the combined experience of the engineering and selling staff is at the disposal of those engaged in the electrical business.

Construction of a Breakwater Head at Madras.*

By COLIN ROBERT WHITE, M. Inst. C.E.

The construction of a semi-permanent blockwork head to the north-east sheltering breakwater at Madras was described† by Sir Francis Spring, M. Inst. C.E., in 1920. This head was built as a temporary protection to the end of the breakwater until such time as the steel work for a caisson, to be used in forming the head as originally designed, could be obtained.

The work now described comprised the building of the circular well head 85ft. 9in. high with an external diameter of 48ft. and a centre shaft 18ft. 6in. in diameter, sinking it off the existing end of the breakwater to a depth of 35ft. 6in. into the sea bed, and closing the gap thus formed with concrete blockwork. The well head was made up of a steel caisson 58ft. 9in. high, filled with concrete, on top of which 27ft. of coursed concrete blockwork was built.

The cutting edge and the first 25ft. of the caisson were erected on a timber staging built over the upper end of an existing slipway. The rest of the steel work was erected afloat, the total weight of the steel work in the caisson being 248 tons. A weight of 600 tons of cement concrete was placed inside, of which 330 tons were used to build six radial diaphragm walls between the inner and outer skins of the caisson, carried up to 40ft. above the cutting edge.

Five 6ft. slices of blockwork were built on to the outer face of the semi-permanent head to enable a 33-ton Titan crane to plumb the centre of the caisson when placed in the selected position.

The caisson was moored between the end of the breakwater and three mooring buoys, and, although the sea appeared to be calm, the caisson rose and fell 1ft. and ranged 2ft. from side to side. When the caisson was lowered on the sea bed and sufficient water had been admitted to give a preponderance of 500 tons at high water, it settled 3ft. 6in.

Before concreting started an unexpected ground swell caused the caisson to oscillate and settle still further into the sea bed. Pumping was started to lighten the caisson, but before it was light enough to float, it had sunk in all 8ft. 6in. into the sea bed and was ranging heavily, waves beginning to break into it. Attempts to consolidate the sea bed under the caisson with broken stone ballast proved ineffective, and it was therefore towed back under the shelter of the breakwater.

Before a second attempt to place the caisson was made, two additional strakes of plating were added temporarily, increasing its height by 7ft. 6in., and a timber pile staging, strutted off the end of the breakwater, was built, against which it could be tied back. The broken stone was levelled off at −40ft., and the caisson was lowered on to the prepared bed as on the previous occasion. With a view to obtain the maximum pressure on the bed, the caisson was completely flooded and the valves were left open. It was tied back to the staging with chains taken to the breakwater, the mooring buoys were removed, and their cables were made fast to the caisson and drawn taut with union screws. A bank of rubble was then placed round the outside of the caisson as a protection against scour.

The first 400 tons of concrete were placed under water, and, as the concrete was laid in the caisson, an equivalent weight of water was pumped out. The concrete was of 1 : 2 : 4 mixture for under-water work, and 1 : 3 : 6 when laid in the dry, 16 per cent. of granite plums being added to the latter while it was being trimmed.

The concrete blocks above the steel work ranged in weight from 25 tons to 5·5 tons, being laid in course 3ft. 10in. deep.

The well was sunk by grabbing. Difficulty was experienced owing to the compactness of the sand and mud forming the sea bed. In the early stages it was not considered safe to run the well by pumping, as a blow might have undermined the temporary slices on which the Titan crane was standing. After the well had been sunk 15ft., the level of the water in the well was kept 5ft. below the water-level outside, which had the effect of more than doubling the average speed of sinking.

Sinking was stopped when the cutting edge was 35ft. 6in.

* Official abstract of a Paper about to be published by the Institution of Civil Engineers.

† Minutes of Proceedings, Inst. C.E., Vol. CCX., page 1.

below the sea bed. The inside of the well was dressed off level with the cutting edge, except for a width of 12ft. all round the inside edge, where it sloped up at 1¼ to 1 to meet the cant plate. The well was sealed with concrete up to 2ft. above the top of the cant plates.

The gap between the end of the breakwater and the well head was filled with nine 6ft. slices of blockwork and a wedge of blockwork laid horizontally. The slices carrying the crane were removed, the rubble bed was re-levelled at −40ft., and a bed of rubble 5ft. thick was laid in a trench as a foundation for the rest of the work. The pell mell wave-breaker blocks on the seaside of the breakwater were extended up to the centre of the well head to cover the new work.

A horizontal apron, 58ft. wide, composed of concrete blocks 3ft. 6in. thick on a foundation of a similar depth of rubble, was laid round the well head and along the inside of the breakwater as far as the semi-permanent head, to protect the work against scour.

CORNISH MINING.

INTERESTING details regarding tin and copper mining in Cornwall in early days were contained in a paper read by Mr. A. K. Hamilton Jenkin, of St. Ives, before a meeting of the members of the Cornish Institute of Engineers at Camborne on Saturday, April 17th. Mr. Jenkin said that with the discovery of pieces of melted tin slag in Chun Castle, near St. Just, last summer, they could now say definitely that the working of tin in Cornwall had gone on for over 2000 years at the very least. It was probably correct that shaft mining in Cornwall began about 1450, but the groups of Royal argentiferous lead mines at Bere Alston, Bere Ferrars, and Beerland, on the Cornish border, were much older. There were records of underground mining at these places as early as 1303 and the mention of adits. At another set of mines at Bere Ferrers there was drainage in 1480, in addition to adits and windlass and buckets, with a water wheel working a small suction pump. The wages of the miners were fourpence a day, which compared very favourably with that of other skilled labour at the time. In the Middle Ages the bulk of the world's tin was produced in South and Western Devon, but afterwards the industry moved steadily westward. Penzance was made a coinage town in 1663. The earliest alluvial streams they knew of were in the St. Ives district, dating from 1503, but earlier history had been quite lost. By 1580 there were copper smelting works at Perranporth, where a number of German workmen were employed, much to the annoyance of some Cornishmen, who complained that men of the county could do the work as well at less wages. In Elizabethan times, Poldice, near St. Day, was a great mine. Owing to the importance of copper being realised there was a great development in mining at the beginning of the eighteenth century, during which the whole of the Camborne and Redruth area was plotted into tin bounds, which were jealously guarded for the mineral they contained. Owing to a fall in the price of copper consequent on the enormous and cheap production from Parry's mine in Anglesey, Cornwall passed through a period of great slump at the end of the eighteenth century, and attention was turned to tin, with the result that production rose too high and the price went down. Within thirty years of this dark period mining in Cornwall, however, had attained a pitch of prosperity never dreamed of. Mines started up in all directions, foundries ond engineering works were opened and railways and roads made. The county was revolutionised and became one of the greatest mining camps in the world. From this recovery in the early part of the nineteenth century such noted properties as Tolgus, Barncoose, Roskear, and Dolcath dated.

SIXTY YEARS AGO.

IN 1866, although the conclusion of the American Civil War had brought a flood of prosperity to this country, continental competition, particularly in the engineering and allied industries, was beginning to trouble our manufacturers. A great strike in the British iron trade had given the Belgians an opportunity to penetrate our home markets, and after it was over they continued to retain their footing and to send over regular shipments of iron. Some considerable soreness, too, was expressed, it would seem, by many at the fact that the Great Eastern Railway had found it necessary or desirable to import locomotives from France. The growing menace of foreign competition in the engineering industry was clearly recognised, and in a leading article in our issue of April 20th, 1866, we sought to investigate the reason why such competition should have arisen. The conclusion reached was that it was mainly a matter of wages, although it was also affected by the growth of trades unionism. The laws against combinations amongst workmen had been repealed in this country in 1824. France did not do the like until 1865, and in Belgium such combinations were still illegal, although discussions were proceeding regarding the removal of the restraint. Taking Belgium as an example, the wages paid on the Continent to workers in engineering establishments were, we said, only about half the average paid in this country. A fitter at Charleroi received, we stated, from 2s. 6d. to 3s. 4d. per day of eleven working hours. Journeyman patternmakers received about the same wages. Erectors and superior workmen were sometimes remunerated at a maximum rate of 4s. 2d. a day. In Manchester, where the conditions were a good average between the high wages paid in London and the lower rates of the North of England and Scotland, a fairly good fitter received at least 30s. per week of 57½ hours, and to skilled men 32s. or 33s. or even more was given. For overtime about 25 per cent. extra was paid. The average Belgian fitter, therefore, received about 3d. an hour, while his fellow in this country obtained about 6d. The Saturday afternoon holiday was unknown in any country except this. How the continental workers succeeded in living on their wages we were at some loss to say, for the cost of living was very little less than it was in Great Britain. It was not correct, we said, to suppose that the British worker's output was superior in quality and quantity to that of his continental rival. He had doubtlessly more muscle and sinew. Excavations on the field of Waterloo showed, we said, that the British skeletons possessed larger and more massive bones than those of their allies or enemies. But, with the growth of mechanical invention, physical strength and skill were required in diminishing quantity in our workshops. We urged the British workers to beware in time before they pushed their employers for higher wages and shorter hours. Until continental wages were raised to the level of those paid in this country there need, we concluded, be no surprise expressed at the importation of a few foreign locomotives into this country.

TRIPLE-SCREW LINER LAURENTIC.

SATISFACTORY progress is being made, we learn, with the construction of the new White Star triple-screw liner Laurentic, at the Belfast yard of Messrs. Harland and Wolff, Ltd., and it is expected this liner will be launched next October. The Laurentic is destined for the company's Canadian service, but will mark a distinct advance in size and equipment, as compared with the existing fleet. With a gross tonnage of about 18,700, she will be not only the largest vessel of the White Star Canadian fleet, but also the largest cabin and third-class ship on the St. Lawrence route. Her dimensions will be 604ft. overall, with 75ft. beam, the maximum for the safe navigation of the St. Lawrence River up to Montreal. As regards her accommodation, the Laurentic will have the advantage of every improvement which recent experience has devised and tested. Besides state room accommodation for 600 cabin passengers, there will be berths for over 1000 third-class passengers.

The propelling machinery will consist of two sets of four-cylinder expansion, balanced, reciprocating engines operating with wing propellers and a low-pressure turbine on the centre propeller, and will be designed to give a sea speed of 16½ knots. Careful attention is being paid to the question of heating and ventilation, navigation and safety devices.

The new steamer will have large cargo accommodation, with an exceptionally large amount of refrigerated space for the carriage of dairy produce and other cargo which requires cold storage. Arrangements will also be made for the transport of uncrated motor cars, while the most efficient cargo handling devices will be installed. The new Laurentic should become a useful link in the increasing trade between this country and Canada.

American Engineering News.

CONVEYORS IN COAL MINES.

Among modern improvements in mining thin seams of coal in American collieries is the use of conveyors to carry coal from the face to a convenient loading point, one advantage being the reduced breakage of coal. In one design, the conveyor consists of hutches or small wagons of sheet iron having only a bottom and one side, mounted on 3in. wheels with roller bearings and riding on a line of 16 lb. rails of 19in. gauge. The hutch is 6ft. long, and 24in. wide, with its side 10in. high. They are coupled together in trains operated by an electric winding engine, with ⅜in. wire cable. When loaded by hand the train is pulled to the dumping point, where the hutches pass under a plough which throws the coal off through a chute into a mine wagon standing below. The returning hatches carry timbers, props and supplies. Another design has two continuous chains carrying scrapers set at an angle and travelling in a chute or trough. This has an effective length of 300ft., and is driven by a 15 horse-power electric motor. A simpler machine has an ordinary conveyor chain fitted with blades or flights which travel in a trough composed of iron sheets, 10ft. long and 3ft. wide, bent to give a flat bottom 1ft. wide with sides sloping at 45 deg. In this case the conveyor has an inclination almost steep enough for the coal to slide by gravity, so that only a 5 horse-power motor is needed to operate the chain.

STRENGTHENING A 416FT. BRIDGE SPAN.

For the crossing of the Columbia River, in Washington, the Great Northern Railway, built in 1892 a steel bridge, having a main through truss span of 416ft., a deck truss span of 250ft., and about 200ft. of steel trestle or viaduct approach. With the rapid increase in weight of locomotives and trains and the increasing traffic, it became necessary to strengthen the bridge, but at the same time to keep it open for traffic. For the big span, the unusual method adopted was to erect the new trusses outside of the old ones, connecting each pair so as to act as a single truss in carrying the load with proper distribution. Owing to the depth of the river, it was impossible to place falsework, and the new trusses were erected therefore as cantilevers, balanced anchor arms being built first and loaded with steel rails. These anchor arms are temporary only, and will be removed when the trusses are completed, but are so designed as to form parts of the trusses of other bridges. While one end of the span rests on a masonry pier, the other end is carried by steel columns braced together and seated on pins, forming a rocking panel to take up expansion and contraction movements. The 250ft. span will be reinforced by a new middle truss on the centre line, its top chord or boom being set low enough to carry the cross girders of the span. The viaduct will be strengthened in the same way by a new line of plate girders in the centre line, supported on new steel columns.

CONCRETE ROADS.

A study of the economic value of steel reinforcement in concrete has been made by the American Highway Research Board, which has developed several conclusions:—(1) Cracking and subsequent disintegration is a function of time, so that cracking is a measure of the life of the pavement; (2) steel reduces the rate of cracking and increases the life; (3) reduction of cracking is effected more economically by steel reinforcement than by additional thickness of concrete; (4) it is effected to better advantage by small closely-spaced steel members than by larger members more widely spaced; (5) increasing the weight of steel netting from 25 lb. to 56 lb. per 100 square feet reduced the cracking considerably; (6) such reinforcement reduced cracks 35 to 70 per cent. in pavements of equal thickness; (7) such netting, together with steel bar matting of 64 lb. per 100 square feet, reduced cracks more than 1in. additional thickness of concrete; (8) in good crushed stone concrete, netting of 56 lb. or bar reinforcement of 170 lb. per square foot, reduced transverse and longitudinal cracking as effectively as an additional 2in. thickness of the concrete; (9) netting of 38 lb per 100 square feet is effective in a thin concrete surfacing upon an old concrete road; (10) an additional edge thickness of concrete reduced corner cracks more than steel reinforcement, but the latter arrested the cracks and prevented progressive destruction; (11) any reinforcement across cracks tends to hold the fractured parts together; (12) bar reinforcement across transverse joints, without proper provision for slippage and clearance, resulted in fracture and subsequent expensive repairs.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

STARTING-UP STEAM PLANTS.

SIR,—The account which you give, in THE ENGINEER of April 16th, of the time taken to start up the steam stand-by plant at Winnipeg is interesting; but I believe that engineers at home could put up much better records. What I have in mind is the rapidity with which big plants in this country were shut down and started again on account of the air raids of a few years ago. The circumstances, certainly, are not completely parallel, but they are sufficiently so to justify comparison, and it would be interesting if some others of your readers would describe their experiences in similar conditions.

During the war time I was in charge of the power plant in a large factory in the Midlands, which comprised twenty-four Lancashire boilers and about 4000 kilowatts of electric generators. The boilers had mechanical stokers. In the event of an air raid the whole of this plant had to be shut down, from full load to absolute silence, within ten minutes, and so soon as the danger was over it was necessary to get under way again as quickly as possible. The interval between stopping and starting might be several hours and there was every chance of the turbines and engines cooling down; we, nevertheless, used to consider that five minutes was a slow start and did get the 'bus-board alive within three and a-half minutes of the "all clear." The success of the operation of starting—which was much more easy than stopping—relied on a storage battery large enough to keep the stoker motors running until the main generators were under way, while the induced draught fans had, as an alternative to the normal motor drive, De Laval turbine drives. Sufficient steam could be boxed up in the boilers to get these little turbines under way and rush up the steam pressure at very short notice. Of course, it was rather risky in starting up the main turbines so quickly, but they were of the impulse type and never failed through that cause.

There was, however, one occasion on which the De Laval auxiliaries served us most splendidly. A serious detonation of explosives in a nearby building wrecked the whole of the power plant buildings and cut off the water supply just before nightfall. We succeeded in making a connection with another boiler-house about a quarter of a mile away and got one of the engines under way, but that water supply also failed, so everything had to be shut down again. When daylight came we cleared the wreckage out of the pump house and managed to get a De Laval going with the remnants of steam in four undamaged boilers. This turbine was belted to a centrifugal pump and enabled us to fill the feed tank from a low-level storage reservoir, so that we were running again less than twelve hours after the disaster. Had we relied on electrical auxiliaries entirely it would have taken far longer to get started again, as the only other alternative method of getting feed water would have been to borrow a fire-engine.

H. D.

Isleworth, April 17th.

A NEW WATERLOO BRIDGE.

SIR,—I am not an engineer, but as possibly a "spurious" town-planner, I take an interest in such questions as the above. I notice from the Press that designs are to be asked only from architects. May I suggest that engineers claim to be associated as well. Perhaps, as a novice, you will afford me space and tolerance to express my reasons.

In the course of my consideration of the problem of London traffic improvement, which may be said to cover the period of a generation, I have come to the conclusion, and have expressed the opinion already, that for the purposes of traffic co-ordination in general, the "Metropolis to be" ought to be furnished with a "lower ground floor" or level in relation to its main arteries. Those would pass under the river in circumstances which cannot well be explained meantime, but in any new bridge arrangement—several are contemplated, St. Paul's, Waterloo, Lambeth, Richmond—ought to be understood and taken into account.

The proposition would mean a double structure, with higher and lower street levels, the latter submerged and connecting up the arteries of the lower ground floor level. The work would, of course, be that of the engineer.

March 29th. O. B. I. T.

THERE are 650 men employed at the Southern Pacific shops at El Paso, but during the twenty-seven months ended last January, 2,734,701 man-hours had been worked with only two cases of injury, which involved the absence of the man concerned from work for over three days. On the Texas and Louisiana lines of the same company there are five workshops, and in them in 1924 there was a reduction of 67 per cent. over 1923 in the number of accidents to men, and in 1925 there were 39 per cent. fewer than in 1924.

Steel Strip Rolling at Sandviken.

(By our Special Representative.)

The engineering world generally knows "Sandvik," by which the Sandvikens Jernverks Aktiebolag, of Sandviken, Sweden, is the name popularly known. Sandvik tubes, rods and wires are equally familiar where Swedish steel is spoken of, but the firm's international reputation has been built up on its marvellous achievement in the way of steel strip rolling for every conceivable purpose, such, for instance, as belt conveyors, transmission belts, springs of the heaviest and lightest types, safety razor blades and articles for a hundred and one other purposes. But the most difficult of all strip to roll successfully and the one which has done more than anything else to make the name "Sandvik" famous is the production of the strip steel which is used for making band saw blades.

In the old days when the widths of band saws were limited to a few inches and they were used only on machines with soft-lagged pulleys, destined to run from a third to a half of the speed at which these big blades are now run, quality, comparatively speaking, was a small matter. But now, when band saws of any width up to 18in. or 20in. are used and are run steel against steel at some 8000ft. or 9000ft. per minute, the steel from which such blades are made is a matter of the utmost importance. Not only is it a question of the analysis of the steel itself, but it must be treated, from the time when it is in the form of an ordinary ingot until it leaves the factory in rolls, which may be anything up to 330ft. long by 24in. wide, with the greatest care in every one of the many intricate processes to which it is subjected.

It is "Sandvik's" treatment of this particular class of strip steel which I propose to discuss briefly in this article. Let us first consider the sort of stresses to which a band saw blade is subjected when in actual work. Apart from running at the speeds above mentioned, it is alternately bent throughout its entire length round its saw pulleys and straightened again many hundreds of times a minute. The pulleys that bear it are strained apart to an extent which subjects the thin blade to a tension, in the case of wide band saws, of anything up to 1000 lb. per inch of its width, and it may be called upon to negotiate a depth of cut of anything up to 6ft. or 7ft. in hard wood.

A further serious handicap to the life of a saw is that, owing to its constant tendency to stretch in work on the toothed or cutting edge, it must be subjected not only once but practically every time it is taken off the machine, to the misnamed process of "tensioning." This means hammering or cold rolling the centre of the blade which, every time that it is done, tends to weaken its fabric by crystallisation.

With the analyses of these band saw steels we will not deal. Sandvikens have many formulæ of their own, and also some of their bigger customers in England and America have special formulæ which they prescribe. Neither Sandviken nor the firms concerned are in the least keen to divulge their prescriptions, which is only natural. But, as Sandvikens have remarked, "analysis is only a portion of the battle." The truth may be realised by considering the processes which are outlined below.

In passing, it is as well to point out that not only do Sandvikens supply large quantities of this band saw strip steel to most parts of the world, including Japan, but that their best and constantly increasing customers are in the United States, which country is popularly supposed to be the home of wide band saw strip steel—and this in spite of the heavy protective tariff.

At one time American wide band saws were regarded in Europe as the last word in perfection, and were paid for accordingly. The development in making these blades in Europe of late years has greatly reduced the American prestige in this respect. In fact, at the present day, at all events, one Sheffield firm is making and despatching considerable quantities of wide band saw blades for use in the lumber mills in North America. It will, however, come as news to a number of people that many of the so-called "American" band saw blades are actually made from Sandviken's strip steel. Sandvikens hold such strong views on the subject of treatment being as important as analysis, that they find it advisable that every department throughout the factory should know as much as they themselves do of the work for which any particular steel strip is destined. Thus, particulars of this follow each order right through the departments—where individual customers are known by cipher titles—from the blast-furnace to the testing shop.

The Sandviken factory—Figs. 1 and 2—is situated inland from Gefle, the timber port on the Baltic, and is distant from that centre about one hour by rail. The growth of the works has been steadily and rapidly progressive since its foundation in 1862 by Goran Goransson, the father of the present chairman of the company. It was old Goransson who first solved the problem of turning to commercial account the great invention of the late Sir Henry Bessemer for steel production on the Bessemer process. But, while Sandviken may be said to have owed its birth to the Bessemer process of steel making, and Bessemer furnaces are in use there to-day for the production of certain special classes of steel, nine-tenths of the present production at those works and all of the strip steel, with which we are more particularly concerned here, is done by Siemens open-hearth furnaces. The works occupy 107 acres, and perhaps the first thing that strikes the visitor is the great size of most of the shops. This is due very largely to the necessity for ample elbow room where the hot and cold rolling of long strip and rods—often, as above stated, over 300ft. in length—are dealt with. For, while the strip is coiled as it leaves the hot rolls and coiled again as it leaves the cold rolls, it has again to be uncoiled for testing, dressing and inspection.

Three thousand men are employed, and of them the greater part are skilled, as the mere handling of these uncoiled lengths is done mainly by up-to-date plant for the purpose and reduced as far as possible by scientific laying-out. The total horse-power of the electric motors used in driving and lighting the works is 18,000, generated by water power stations. This is supplemented by a stand-by steam turbo-generating plant of 4500 horse-power. There is a big three-storey laboratory which contains a full and extensive testing plant, both mechanical and chemical, and a very complete and interesting museum containing specimens of every product made by the firm.

At the time of my visit Mr. Goransson, the present chairman of the company, was away, and I was courteously received by two of his co-directors, Mr. Lars Yngstrom and Mr. H. Krook, and was shown round the works by the general technical manager, Mr. Victor Magnuson. "We do not court publicity," said Mr. Yngstrom, "nor do we as a rule show people round our works. We are, however, going to show you all through the strip making, but, like the piano-maker, who when he showed his process of manufacture to a competitor, we are going to show you everything except how we put the tone into our

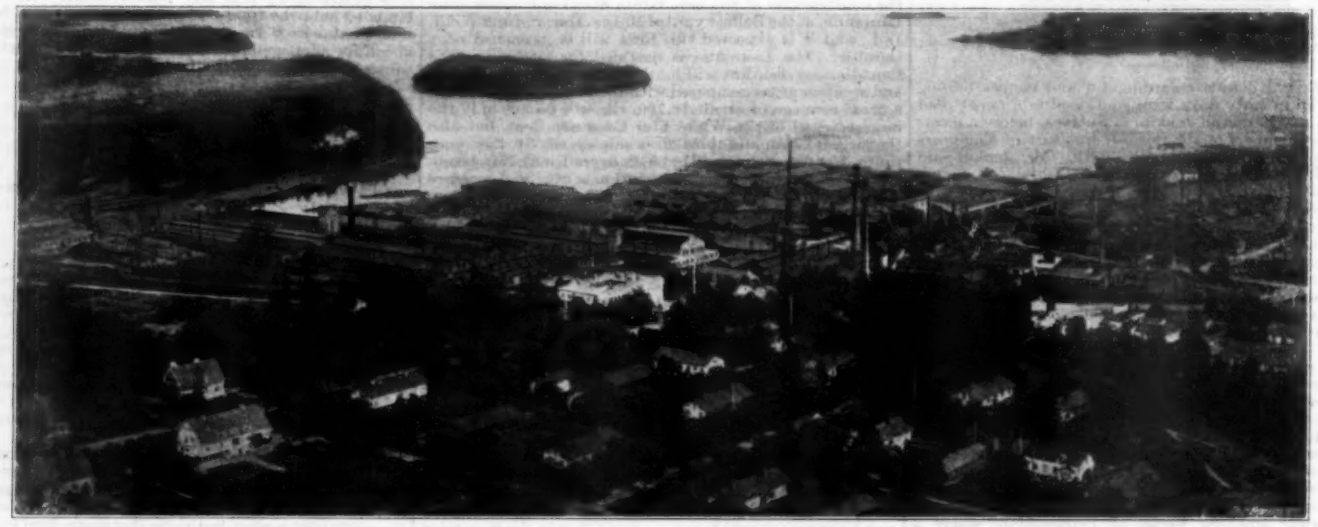

FIG. 1—AERIAL VIEW OF THE SANDVIKEN STEELWORKS

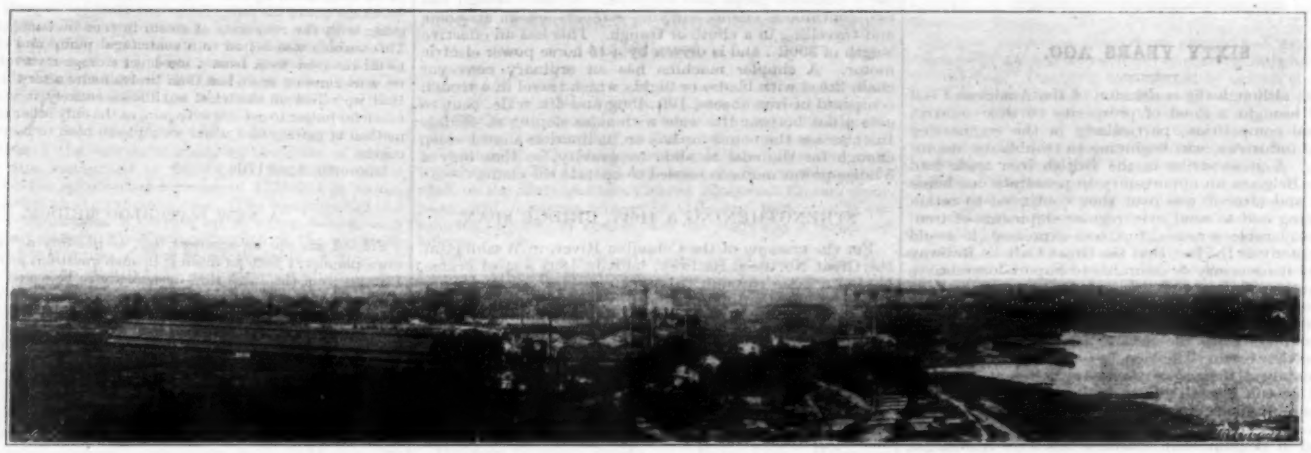

FIG. 2—AERIAL VIEW OF THE TOWN OF SANDVIKEN AND THE STEELWORKS

piano. That is the only mystery about our methods." One other very natural reservation was made. Some of the machines used are of a very special nature, invented by the company for its own use, and them I must not illustrate or describe in too much detail.

All the strip is made of "charcoal" steel, and the amount of charcoal consumed per annum in the process is from 5 to 6 million cubic feet. Fig. 3 shows a portion of the wood store for charcoal production and Fig. 4 a charcoal oven house. All ore is melted by Siemens open-hearth furnaces, and the greatest care is taken in weighing and mixing the ores and measuring the quantities of charcoal used. All ingredients are "home grown," and the company lays great stress on this fact, as by adopting this policy it avoids the uncertainty entailed by the unknown quality of purchased raw materials. All furnaces are of comparatively small capacity—30 tons in twenty-four hours—and all ingots are small. These two factors, it is contended, are largely accountable for obtaining that strict uniformity in the texture of the steel, without which these thin steel bands, which are destined to stand such severe and varied stresses, would be useless. Fig. 11, page 470, shows the process

FIG. 3—WOOD FOR CHARCOAL MAKING

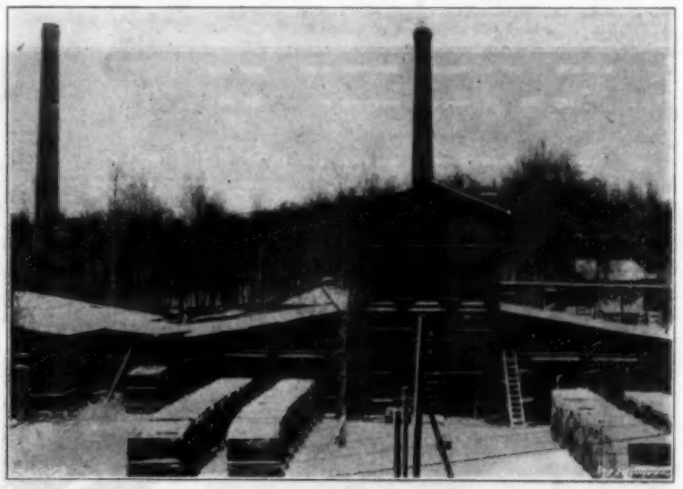

FIG. 4—CHARCOAL OVEN HOUSE

FIG. 5—BILLETS FOR STRIP STEEL

FIG. 6—HOT ROLLING BAND-SAW STRIP

of mixing the ingredients as the furnace is charged, the various ores being automatically weighed by a steelyard from which the charging shovel is suspended. The charcoal used in the charge is measured with great accuracy. Fig. 9, page 470, shows the process of casting pig iron from the molten charge.

There is nothing which needs description in the oepn-hearth steel-making process which follows, but Fig. 12, which shows one of these furnaces being tapped, gives an idea of the magnitude and practical arrangement of the plant in this department. The resulting ingots are about 4ft. in length and about 11in. by 10in. square at the wider end. There are no less than eleven complete sets of hot rolling mills for reducing the ingots, first to billets or slabs, and finally to thin strip. Fig. 10 shows one of the cogging mills for the former process. After cross-cutting the billets to the dimensions for producing the length of strip eventually required, all surface blemishes are removed by pneumatic chisels and the billets stored in stacks, as shown in Fig. 5. The billets are heated in a long progressive furnace, through which they are carried automatically from one end to the other. In this the temperature is regularly and slowly increased throughout the progress of the billets, up to 1000 deg. Cent. The rate of feed varies according to the dimensions of the billets.

Fig. 6 shows the hot rolling of the strip, but this, as any picture must, fails to convey an idea of the movement and rapidity with which these long and ever-increasing lengths of red hot material, sometimes as much as 24in. in width, squirm about the floors in and out of the rolls on either side, finally to be wound automatically round a drum in preparation for the cold rolling and annealing. Band saw strip must be reduced from the billet to the strip in one heating, thus the process of rolling is very rapid. The diameters of the rolls used vary considerably, according to the widths of the strip, the amount of variation representing a range of from 12in. to 20in. The minimum thickness produced by hot rolling is 1 mm., but this limit can only be obtained on narrow strip, say, up to 3in. wide. For most purposes the strip is reduced to 2½ mm. or rather less, below which the strip has a tendency to run thick in the centre. Eighteen inch band-saw strip is hot rolled down to a thickness of 5 mm. This leaves to the cold rolling a further reduction of about 2 mm., or possibly rather more, to bring the blade down to the required gauge, according to the diameter of the saw pulleys on which it is destined to work.

The process of cold rolling, which also entails, to some extent, the straightening of the strip by the adjustment of the rolls, and the obtaining of a regular thickness, is carried out in a very large shop—see Fig. 7. In this much of the rolling is done by plant which does not differ materially from that employed elsewhere for the purpose, but at the time of my visit a new and very elaborate and costly rolling mill was being tried. It has been invented by the company for the purpose of speeding up the output, more particularly of wide strip. Of it, unfortunately, I am not allowed to give a description. The diameters of the cold rolls used vary according to the widths of the strip. In fact, approximately the diameter of the roll is about equal to the width of the strip up to a maximum of 18in.

The process of cold rolling is repeated as often as is necessary to reduce the strip to the required gauge, the strip being unrolled as it is fed through the machine and re-coiled as it leaves it to be placed in the annealing pot, for annealing between the operations of cold rolling. Throughout the annealing, which takes place in the coke gas furnaces shown in Fig. 8, the enclosed strip retains its brightness. The first annealing is done as a rule at a heat of 700 deg. Celsius raised in certain cases to 750 deg. On the exact regularity of the heating at this stage and the very slowly cooling of the strip afterwards depends the success or otherwise of the saw. A series of pyrometer charts indicates the heat at all times at both ends of the furnace. The process of annealing, which may be repeated four or five times, varies in duration between eight and ten hours. After the first annealing somewhat lower temperatures are used.

All band saw strip for saws of 4in. in width and over are rolled to the widths concerned. For narrower band saws several are rolled in one strip and the strip is divided afterwards as it passes through the edging machine. The edging is done after the final cold rolling by means of small circular steel knives, and so accurately has the amount of material required been gauged in the billet state that after the hot and cold rolling there is seldom more than ¼in. to be trimmed off either side to bring the strip to the finished width. There is virtually no limit to the thinness to which the strip may be cold rolled. I was shown a small roll of stuff which looked like silver foil. It was cold-rolled strip of a thickness of 1½ hundredths of a millimetre.

Following the cold rolling, annealing and trimming, comes the equally delicate process of hardening and tempering the strip. This is done entirely automatically on a single machine, some 20ft. in length, the strip being merely unwound from its coil as it enters the heating furnace and wound up again as it leaves the tempering plates. The speed at which the strip passes through varies according to its thickness and width. At the time of my visit, strip about 6in. wide was being handled, and the speed was about 5ft. per minute. As it enters this machine it passes first through a coke gas oven, leaving it at a bright red heat. Within a few inches of the oven's mouth it plunges into a bath of mixed whale and vegetable oils, emerging brittle and hard. This bath is about 6ft. long. Thence it passes between two long heated tempering plates and leaves them a cherry red. After being tempered it is wound off on to a second drum. The proper regulating of the rate of feed to suit the two different grades of heat through which the blade

must pass, requires the most delicate adjustment of all the factors in this automatic machine, as the slightest over or under heating or variation of the feed would mean disaster. Skill and experience have rendered this difficulty almost negligible, I was told. If it should be found at any time that the temper is too soft, it can be readjusted by means of passing the strip again through independent tempering plates without checking the output of the machine. If, however, it is too hard, the machine must be re-adjusted as to heating or feed, or both, and the strip re-passed.

After the strip has been tempered, it is seldom touched by the hammer until it reaches the inspection department, but before being ground and polished, it is subjected most carefully to tests for tensile strength and hardness by the scleroscope and other testing machines. In fact, testing machines to suit the requirements are located in all the departments concerned, apart from those in the laboratories of the company. The grinding is done by British natural stones, the strip being fed automatically between them, and it is subsequently polished between emery stones and brushes. No tests for cracks and lumps are made until the strip has been ground and polished, as, before that stage, many of the very minute

FIG. 7—COLD ROLLING DEPARTMENT

FIG. 8—ANNEALING FURNACES

blemishes, which must be detected and corrected, would not declare themselves. The final testing and inspection of the strip is very elaborately done in a vast shop in which these long lengths can be laid out flat, and in conditions of perfect lighting. Here every inch of the strip is gone over with the utmost care, and slight irregularities are corrected by the rolls and the hammer, and, if required, the strip can be straightened by stretching. Here, too, all cracked, lumpy or badly twisted strip is scrapped.

My impression as I left these works was that I ought to have spent a month there rather than eight hours, but I came away with the satisfactory feeling that I had solved the one secret of the Sandviken quality that the directors had so carefully withheld from me. They "put in the tone of their piano" by dint of the extraordinary patience and skill with which the whole of the processes are carried out, from the blast-furnace to the polished strip, the intelligent knowledge possessed by every one through whose hands the stuff is passed as to what it is destined to do, and a sort of atmosphere of understanding and co-operation which pervades the whole organisation.

International Shipping Conference.

THE representative International Shipping Conference held in London on Wednesday, Thursday and Friday, April 14th, 15th and 16th, had before it a large programme of questions on which international action is necessary.

Mr. Walter Runciman presided over the proceedings, and resolutions were submitted dealing with flag discrimination, immunity of State-owned shipping, taxation problems, co-ordination of international organisations, deck cargoes, oil discharge, load line, oil tanker freeboard, safety of life at sea, and wireless telegraphy. A statement was also made regarding the present position of the controversy on the subdivision of passenger ships.

Sir Kenneth Anderson, who raised the question of subdivision, said that, although the controversy on the subject had died down, a good deal of work had been in progress behind the scene. It would be recalled, he said, that, when the International Shipping Conference met in London in 1924, it had before it the then recently issued report of the Informal Committee to which the question had been referred by the Board of Trade. The report of that Committee confirmed the opinions which had been expressed by shipowners, and was of a very practical character. Since that time the British Government Department concerned had been engaged on an intensive study, not only of the report of the Committee, but of the mass of material which had accumulated during a number of years, and had undertaken the task of drafting a set of regulations to give effect to the conclusions which that mass of material suggested. It was known that the time was near at hand when those draft regulations would be submitted for the consideration and criticism of other Governments. It was recognised that new regulations were necessary, as the old Convention was an incomplete document, and as far as the criterion of safety was concerned, was a cypher without a key. The uncertainty of the present position was very embarrassing for shipowners, and it was satisfactory, therefore, to feel that the question of the subdivision of passenger vessels was now entering its last phase, and that there would emerge from what was now being done, a convention which would be acceptable both to the Governments concerned and to shipowners.

The difference of practice which exists in connection with oil tanker freeboard was the subject of a statement and a resolution. Mr. A. Maclean (Great Britain) said that, having regard to the fact that 5,500,000 tons gross of ships built for the carriage of oil in bulk were in service, commercial interests were involved in that the United States shipowners were unfettered by regulations, and could load their ships as deeply as they wished, compatibly with safety. It was felt that some latitude should be allowed to tankers, as compared with ordinary cargo vessels, having regard to the fact that the tanker was strongly built, was divided into a great many compartments, had only small hermetically steel hatches, and had a fore and aft bridge. The danger for the men on deck was practically nil. American shipowners who anticipated legislation with regard to tanker freeboard had submitted their case to a sub-committee on which shipbuilders, underwriters and others were represented. That committee reported favourably on the application of the owners. It was decided, however, to deal with the matter internationally, and a committee, which included representatives from the various maritime countries, was appointed, and had passed a resolution suggesting that all the countries represented in the International Shipping Conference should approach their Governments with the object of obtaining, in any international load-line regulations, a reduction in the freeboard of tank vessels carrying petroleum in bulk, as compared with ordinary cargo vessels of similar dimensions and design. A technical sub-committee was afterwards appointed, and information was supplied to that committee by American owners, who, alone, had experience of deep draught. The particulars supplied gave actual records from many thousands of voyages, and it was shown that many of the vessels had a freeboard of about 40 per cent. less than would have been permitted in British ships. The question had been discussed by the sub-committee immediately before the opening of the Conference, and while the American members of the committee recommended a reduction of freeboard in international regulations up to 21 per cent., the British representatives suggested that 15 per cent. would be a better figure to adopt. It was ultimately decided that the resolution of the International Oil Tanker Freeboard Committee and the report of the Technical Sub-committee, should be submitted for the careful examination and consideration of all Governments.

Sir Norman Hill dealt with the regulations for the provision of boats and rafts. He pointed out that the Merchant Shipping Advisory Committee, of which he was chairman and which represented all interests concerned, had always upheld the principle that in all legislation connected with the safety of life at sea, the safety of the ship must come first, and that any steps taken to minimise the consequences of disaster in the way of the provision of boats and similar safeguards, must always be subject to the prime consideration of the safety of the ship. That advice had been disregarded, and, even in the latest rules of the Board of Trade, the principle of boats for all—in a somewhat less stringent form than previously, however—was still maintained. The Board of Trade had failed to carry out the recommendations of the Committee that boats should only be provided up to such a number as could be stowed without creating an impediment. The Merchant Shipping Committee could not admit the principle of determining the boat capacity according to the total number, or a fixed percentage, of the persons for which the vessel was certified, so long as that number was fixed without regard to the boat-carrying capacity of the vessel. It should be known that, to cumber a ship with boats which could not be launched, only increased the risk of loss of life in the event of disaster to a ship at sea. The use of light rafts was preferable. The Board of Trade had power to allow the use of buoyant apparatus in place of lifeboats, but that power was associated with the provision that total lifeboat capacity for 75 per cent. of the persons on board must be provided.

On the subject of wireless telegraphy, Mr. W. A. Soutar stated that an International Conference on Wireless was to be held at Washington in 1927, and that it was thought that wireless on ships should be one of the subjects for that Conference. The Chamber of Shipping had been in touch with the Board of Trade on that question, and it would be examined by the Conference Committee on Wireless. The discussion generally revealed the opinion of shipowners that all wireless regulations should be revised, and that the rules for distress signals, particularly, required alteration. A resolution asking for the calling of a Diplomatic Conference to revise the Convention of Safety of Life at Sea was passed.

INSTITUTE OF TRANSPORT.

THE sixth congress of the Institute of Transport will be held at Birmingham from Thursday, 13th, to Saturday, May 15th next. On the previous Wednesday evening the president, Colonel Sir Joseph Nall, D.S.O., will hold a reception at the Queen's Hotel, from 7 to 10 p.m.

The business portion of the Congress will be confined to the mornings of the Thursday and Friday, the meetings taking place at the Council House. On the Thursday morning, at 9.45, the Lord Mayor of Birmingham will extend a civic welcome to the delegates. Then at 10.15 a.m. the following papers will be read and discussed:—"Industry and Transport," by Mr. George Cadbury, jun., managing director of Cadbury Bros., Ltd.; and "Road Passenger Transport," by Mr. Alfred Baker, the General Manager of the Birmingham Corporation Tramways. In the afternoon there will be alternative visits to (1) the works of Cadbury Bros., Ltd., at Bournville; (2) the Kyotts-lane Depôt of the Birmingham Corporation Tramways; and (3) the Curzon-street Goods Station of the L.M. and S. Railway. In the evening, at 7.30, the Lord Mayor and Lady Mayoress will entertain the Congress at a conversazione and dance at the Council House.

On the Friday, at 10 a.m., in the Council House, the following papers will be presented for discussion:—"Traffic Control," by Mr. J. H. Follows, Chief General Superintendent, L.M. and S. Railway; and "Transport in England: a Brief Historical Survey," by Dr. C. Grant Robertson, Principal of the Birmingham University. In the afternoon there will be alternative visits to: (1) The carriage and wagon shops of the London, Midland and Scottish Railway at Derby; and (2) the works of the Austin Motor Company, Ltd., at Longbridge. In the evening, at 7 p.m., the annual dinner of the Midland Local Section of the Institute will be held at the Queen's Hotel at 7 p.m.

The Saturday will be devoted to the following alternative motor coach tours:—(1) Birmingham, Stonebridge, Kenilworth, Guy's Cliffe, Warwick, Stratford-on-Avon, Henley-in-Arden, Birmingham (56 miles); (2) Birmingham, Droitwich, Worcester, Great Malvern, Worcester, Birmingham (70 miles); (3) Birmingham, Kidderminster, Bewdley, Stourport, Holt Fleet, Droitwich, Birmingham (55 miles); and (4) Birmingham, Sutton Coldfield, Lichfield (Cathedral), Birmingham (32 miles). During the mornings of the Wednesday and Thursday visits for the ladies of the party have been arranged to the showrooms of (*a*) Elkington, Ltd., and (*b*) the General Electric Company, Ltd., at Witton.

Further particulars of the Congress may be obtained from the secretary, Mr. A. Winter Gray, 15, Savoy-street, London, W.C. 2.

IN view of the fact that the construction of the Edgware Extension of the London Electric Railways was assisted by contributions from the Government under the Trade Facilities Act, it is a satisfaction to know that the traffic over it was 26 per cent. better in 1925 than in 1924. It is said that if the present rate of progress were to continue for another three years—and there should be no doubt of that—the line should be contributing quite substantially towards the income of the railway company.

Railway Matters.

THE South African Railways are going to spend £100,000 in relaying with 80 lb. rails the track of the Worcester-Mossel Bay Railway, which they recently purchased from the New Cape Central Railway.

IN a letter in *The Times* of the 14th instant, Mr. J. G. H. Warren, the author of "A Century of Locomotive Building," pointed out that coke was smokeless and required a smaller grate for consumption than coal. He suggested that some of his railway friends should experiment with coke to ascertain at what price it could compete with coal.

AS appertaining to the Fenny Stratford level crossing disaster of December 7th, it may be noted that during January last there were forty-four cases of gates being run into by motorists on the Fort Wayne division of the Pennsylvania system, and that during the whole of 1925 there were 224 such accidents and in 1924 there were 249.

BECAUSE of a reduced staff with each train and an economy in fuel consumption, trains of the motor car type—originally introduced by the late Mr. Dugald Drummond—are again becoming popular. Instead, however, of using old light locomotives, the engine and coach are self-contained. In this connection it may be noted that the London and North-Eastern Railway Company has recently ordered three such "trains."

ONE sequel to the grouping of the companies that now form the Southern Railway is the proposed improvement in the lines, hitherto independently owned, so as to form a continuous path along the southern coast. One such place is at Ramsgate, and there the work is already in hand. It will shortly be possible to pass direct between Margate and other places on the Thanet coast and Dover. Another case is at Ashford; it is to be remedied by a loop through Smeeth. There yet remains, however, the problem of trains having to run into and then out of Brighton.

THE number of passengers on the newly electrified area of the Southern Railway was 12 per cent. greater last year than in 1924. It must be remembered, however, that the City and South London was in full service during 1925, but was closed wholly for a long period in 1924 for reconstruction. Among the proposed extensions in the electrical services on the Central or "Brighton" section are the lines between Victoria and London Bridge *vid* Mitcham Junction to Sutton and Epsom, from Purley to Epsom Downs, and, possibly, Tattenham Corner and from the Crystal Palace to Beckenham.

THE necessity for railway companies to have a depreciation fund or a suspense account is illustrated in the case of the Metropolitan Railway last year. That company had to spend a large sum out of revenue on earthworks, with the result that the item under that heading was £8369, as compared with £3948 in 1924. That was adjusted by taking £6379 from reserves. Again, the year 1924 brought the unusually splendid traffic of the British Empire Exhibition and the company was able to spend money more freely. On the purchase of materials for relaying the permanent way £13,341 was spent, but only £463 in 1925; and £35,621 on the maintenance of stations, depôts and offices, as against £15,724 last year. Moreover, the maintenance and renewal of way and works—Abstract A—was debited with £6532 transferred to depreciation funds.

THE visit of American hotel proprietors to this country has been characterised by some exhibitions of long-sustained high-speed running. On the day of their arrival—Friday, the 9th—they were brought from Plymouth to Paddington in two trains, one weighing 273 tons and the other 286 tons. The former covered the 227 miles in 233 minutes and the latter in 235 minutes. The first train was drawn by engine No. 4083, Abbotsbury Castle, driver Webber, and the second by No. 4085, Berkeley Castle, driver Salter. On Tuesday the party went to York and thence to Liverpool. On Wednesday Chester and Manchester were visited, and from the latter city two specials, each weighing 326 tons, ran *vid* Crewe to Euston. It is interesting to note that the engines that had been chosen were Private E. Sykes, V.C. (driver, H. Simpson), and Private W. Wood, V.C. (driver, J. Benson), both named after London and North-Western railwaymen. We hear that the respective drivers were definitely instructed not to give any exhibition of speed, but each train covered the 189 miles in eight minutes under scheduled time.

THE preliminary railway returns for 1925, to which reference was made herein on April 2nd, show that the gross receipts from railway working were £199,600,000 and the expenditure £165,000,000. Other businesses brought the net receipts of £34,600,000 from railway working up to £36,700,000, and the miscellaneous net receipts carried that figure to £51,700,000, as compared with £52,290,421 in 1924. Included in the final amount of £51,700,000 for 1925 there is the sum of £6,600,000 from the compensation and general reserves, as compared with £5,000,000 appropriated in 1924. The receipts from railway working were £3,800,000 less than in 1924, but expenditure was only £1,880,000 less, and so the ratio of expenditure to receipts was 83·3 per cent., as against 82·61 per cent. in 1924. The ratios of the Southern and Great Western varied only a little, but the London, Midland and Scottish rose from 82·11 to 82·62 per cent., and the London and North-Eastern from 85·16 to 86·69 per cent. Maintenance and renewal of way and works decreased by £190,000 on the Great Western and by £209,000 on the L.M.S., but increased by £56,000 on the L.N.E. Locomotive upkeep increased by £24,000 on the Southern, by £92,000 on the L.M.S., and by £270,000 on the L.N.E., but decreased by £140,000 on the Great Western. Carriage maintenance decreased by £68,000 on the Southern, by £48,000 on the G.W., by £17,000 on the L.M.S., and by £102,000 on the L.N.E. Wagon upkeep fell by £120,000 on the Southern, by £41,000 on the L.M.S., and by £58,000 on the L.N.E., but was up by £9000 on the G.W. Locomotive running expenses were down by £312,000 on the G.W., by £438,000 on the L.M.S., and by £84,000 on the L.N.E., but up by £158,000 on the Southern. The Great Western saved 2,087,000 train miles, the L.M.S. 307,000, and the L.N.E. 704,000, but the Southern ran 3,420,000 more.

Notes and Memoranda.

A SCOTTISH motorist recently drove a 24 horse-power six-cylinder car from London to Aberdeen, a distance of 547 miles, in 12¾ hours, or at an average speed of about 43 miles per hour.

A NOVEL system of forming concrete culverts, said to be a Japanese idea, was recently demonstrated in Sydney. A trench for the pipe is excavated and in the bottom there is laid a rubber tube. This tube is inflated until it is of the required diameter. Concrete is then tamped in to fill the trench, and when it has set, the rubber tube is deflated so that it can be withdrawn.

IN preventing the spontaneous inflammation of readily oxidisable oils and oil mixtures, especially when on very porous or loose matter, such as wiping rags, the addition of a small quantity of sulphur—say, 2 per cent. on the weight of a varnish—proves, says the *Chemical Trade Journal*, particularly efficacious. A slight heating of the mass may be observed but never any inflammation.

ACCORDING to an official statement made recently in the Canadian House of Commons, it will require about 55,000,000 dollars more to complete the Welland Ship Canal. The total cost up to December 31st last was 60,573,573·83 dollars. The estimates tabled recently include 14,000,000 dollars for this year's work. This latter amount is 1,000,000 dollars less than was voted last year.

AFTER more than a half century of use a line of 24in. wrought iron pipe lined with 2in. of cement mortar, now forming a part of the Boston Metropolitan water system, appears, says the *Engineering News-Record*, on cutting into it to be in good condition, with only a little slime on its inside. The pipe was laid in 1871 as a part of the old waterworks of Charleston, Mass., subsequently included in Boston.

THE importance of low ash in blast-furnace coke has been emphasised in large scale tests at one of the British works, where a reduction of the ash in the coke from 12¼ per cent. to 8¼ per cent. resulted—iron containing ·93 per cent. of silicon instead of 2 per cent. being made—in an increase of output of nearly 30 per cent. and a reduction of coke from 23·24 cwt. to 19·4 cwt. In another test where production of iron containing 2 per cent. of silicon was aimed at, a reduction of coke consumption from 23·6 cwt. to 22·9 cwt. was obtained, and an increased output of 12 per cent.

THE cost of handling a ton of tin-plate scrap in the process for the recovery of the tin, including all labour interest, taxes, depreciation, materials—as chlorine—repair and maintenance, is, according to Mr. C. L. Mantell, just about equal to the amount obtained per ton of detinned scrap, when it is sold as baled scrap on the open market. This cost of handling does not include the nominal cost of the original tin-plate scrap. The values obtained then for the stannic chloride produced—or the tin recovered from such—are entirely on the profit side of the ledger. Approximately 80 lb. to 100 lb. of chlorine are used per ton of tin-plate.

AN article in *British Industries* on the prospects of trade with China concludes as follows:—In spite of the numerous "wars" that have been and are being carried on, important developments are taking place. Factories are springing up by dozens in all the Treaty Ports, and in these ports building is going on at a rate which astonishes even those who are living here. The value of land is increasing all the time, and now stands at a level which is comparable to London or New York. China is undoubtedly a market which is capable of the greatest development during the next twenty or thirty years, and we must prepare to take every advantage of this development.

IN connection with meadow embankment, particularly across salt meadows, where an underlying crust is generally to be expected, the placement of the embankment and settlement can, according to Mr. C. F. Bedwell, be greatly assisted if just prior to placing the fill the entire area on which the embankment is to be placed is broken up by dynamiting. In that manner the fill is permitted more readily and quickly to settle to a firm bottom. This operation can also be assisted by either excavating or dynamiting a ditch alongside the presumed toe of the embankment so as to permit the squeezing out of the under-strata without causing undue heaving of the surrounding meadow land outside the right of way line.

IN the course of a speech at the annual dinner of the Institution of Structural Engineers, Sir Alfred Mond said that this country required more than any people the combination of the engineer and the chemist for the solution of its difficulties. Politicians could not create success unless the engineer and the business man built up the prosperity of the country. Governments could hinder or they could help, but could not create. The country, therefore, could only build up its prosperity on new inventions and research. The solution of the coal problem was not legislation but invention. The chemist and the engineer would together solve the problem of coal distilliation and would be the real saviours of the mining industry.

ACCORDING to the *Iron Age*, the consumption of scrap may be estimated roughly by deducting the pig iron production from the steel production, on the assumption that ore additions approximately make up for weight losses. In the past two years the American consumption of scrap in making steel ingots and castings has run about 15,000,000 tons a year. By no means is the bulk of this tonnage old material. By far the greater portion is works scrap, much of it ingot and other crops, while a considerable tonnage of industrial scrap is produced in working up steel. Probably ingot cropping has increased a trifle in the past ten years. This does not mean that sounder ingots are not being produced than those of ten or fifteen years ago, but requirements of steel buyers have become more exacting, and the ingote of a dozen years ago, if made now, would probably have to be cropped more freely. The supply of old material is not running short, or mills would offer more than they do for what is available. The mills supply themselves with scrap and their customers with better steel by one and the same procedure.

Miscellanea.

THE International Fair at Riga is to be held from June 13th to 27th.

THE Government of Baroda has opened a new harbour at Okha (Dwarka).

THE Sixth Congress of Industrial Chemistry will be held in Brussels from September 26th to October 3rd, 1926.

A RACE for 1½ litre motor boats is to be held on the Thames, over the University Boatrace Course, on June 26th.

THE contracts for the five submarines specified in this year's Naval Estimates are not to be placed until November.

THE Spanish Government has granted a loan of 24,000,000 pesetas for works at the port of La Luz, in the Canary Islands.

A PROMISING tin discovery on Babel Island, near Flinders Island, is reported from Tasmania. The seam of ore is said to be 30ft. thick.

A LODE of quartz containing 3½ oz. of gold per ton is said to have been discovered at Kurannali, near the Frew River, Central Australia.

ON the 18th inst. one of the machines of Imperial Airways flew from Croydon to Nuremburg and back, a distance of 1200 miles, in just over 15½ hours.

KIUKIANG, near the hill station of Kuling on the Yangtze River, is to be provided with a piped supply of potable water and work has been started on laying the mains.

AT a meeting of the Council of the Royal Aeronautical Society, held on Tuesday, April 13th, 1926, Air Vice-Marshal Sir Sefton Brancker, K.C.B., was elected president of the Society.

THE output of coal from the mines of Great Britain during the week which ended on April 10th was 3,696,300 tons, as compared with 4,493,600 tons for the corresponding week of last year.

THE United States Government has called a conference of Maritime Powers, to meet on June 8th, for the purpose of drawing up an international agreement dealing with the pollution of navigable waters by oil, which has long constituted a serious problem.

IT is understood that an irrigation project for the Coimbatore district, involving an expenditure of approximately £35,000,000, is now before the Madras Government awaiting sanction. The scheme, which will be known as the Upper Bhavani project, contemplates the irrigation of at least 260,000 acres.

THE production of pyrites in the United States in 1925 amounted to 170,081 long tons, valued at 650,448 dollars, according to figures compiled by the Bureau of Mines, Department of Commerce. This is an increase of 6 per cent. in quantity, but only 1 per cent. in value, as compared with the 1924 output, which was 160,096 long tons, valued at 645,262 dollars.

DURING this summer two new telephone exchanges, to be called "Rodney" and "Reliance," will be opened in South London. They will have a capacity of 3500 lines and will serve the Walworth and Oval areas respectively. To meet the immediate requirements of the district a new telephone exchange with a capacity of 800 lines was opened on the 19th inst. It is situate in the building occupied by the Hop Exchange in Marshalsea-road, S.E. 1, and will be known as the "Waterloo" Exchange. The provision of a new Bermondsey Exchange is also in hand.

THE Saguenay district, in the Province of Quebec, is to witness the creation of a new industry in the near future. It has been decided to construct a zinc smelter in the Saguenay district, choosing this site because of the fact that there is plenty of electric power available as well as a deep-water port that is open for the greater part of the year. It is expected to reduce considerable quantities of zinc ore, so as to produce about 100,000 tons of zinc yearly, which production would necessitate the construction of a smelter of considerable size, requiring about 50,000 horse-power of electrical energy to operate it.

THE possible ignition of firedamp in mines by means of sparks produced when electric circuits, such as might be used for underground signalling systems, are interrupted by the separation of metallic contacts, has directed special attention to the examination of the several factors upon which such ignition depends. The main purpose of Paper No. 20 of the Safety in Mines Research Board, by R. V. Wheeler (H.M. Stationery Office, Adastral House, Kingsway, London, price 1s. net) is to compare alternating with continuous currents with respect to the ability of their "break-flashes" to ignite firedamp. The experiments described in this paper confirm the results of previous work carried out at Eskmeals, and show that "the character of the current supply, whether continuous or alternating, does not materially affect the incendivity of break-flashes." As the results differ from those found by other experimenters the Board is arranging for further work in an attempt to reconcile or explain the differences in observations recorded.

THE Venezuelan Government has ordered the immediate initiation of work on the enlargement and improvement of the port of Maracaibo, which belongs to the State, and which, owing to the remarkable development of the State of Zulia oilfields, has become of first importance. The old dock will be extensively repaired, the two existing piers extended, the old piling replaced by reinforced concrete piling, and the wharf accommodation extended to admit of at least two ocean-going vessels berthing simultaneously. While the present wharf warehouses accommodate some 8000 tons of merchandise, it is proposed to increase their capacity to a minimum of 12,000 tons, to meet present-day requirements, and to introduce additional facilities for the transhipment of goods to and from interior centres and Cucutá, Colombia. The trade between Maracaibo and Cucuté—which is only a few miles from the international boundary line, Venezuela—is very considerable. There is already a railway, El Ferrocarrill de la Frontera, 72 kiloms. long and of 1 m. gauge, leased to the Cucuté Railway Company.

STEELWORKS OF THE SANDVIKENS JERNVERKS AKTIEBOLAGET, SANDVIKEN, SWEDEN

(*For description see page 466*)

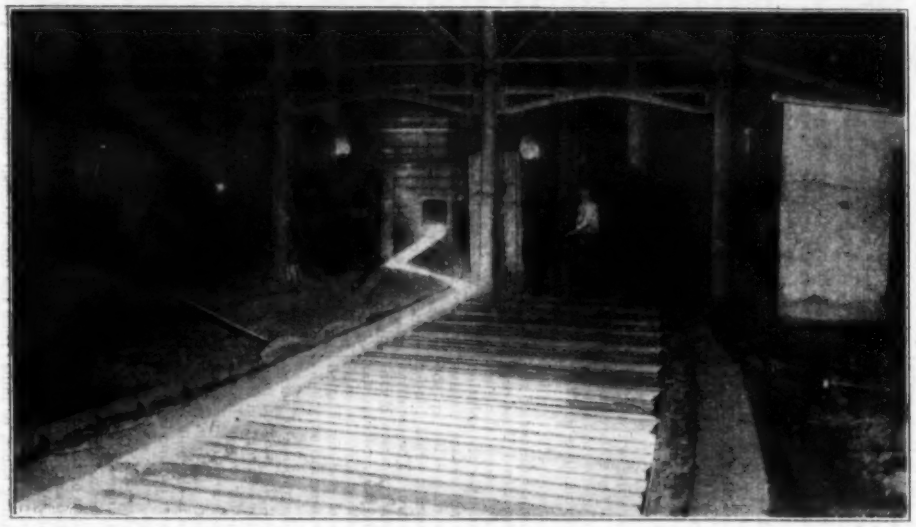

FIG. 9—CASTING CHARCOAL PIG

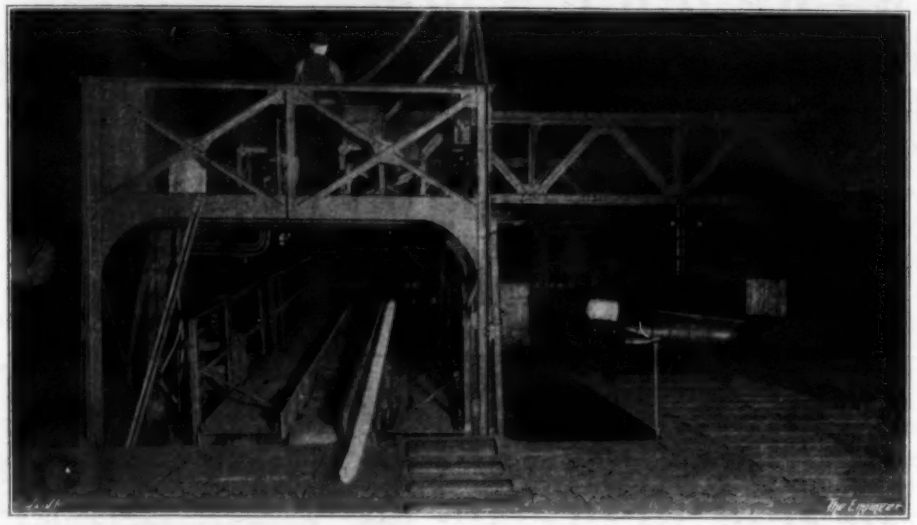

FIG. 10—COGGING MILL

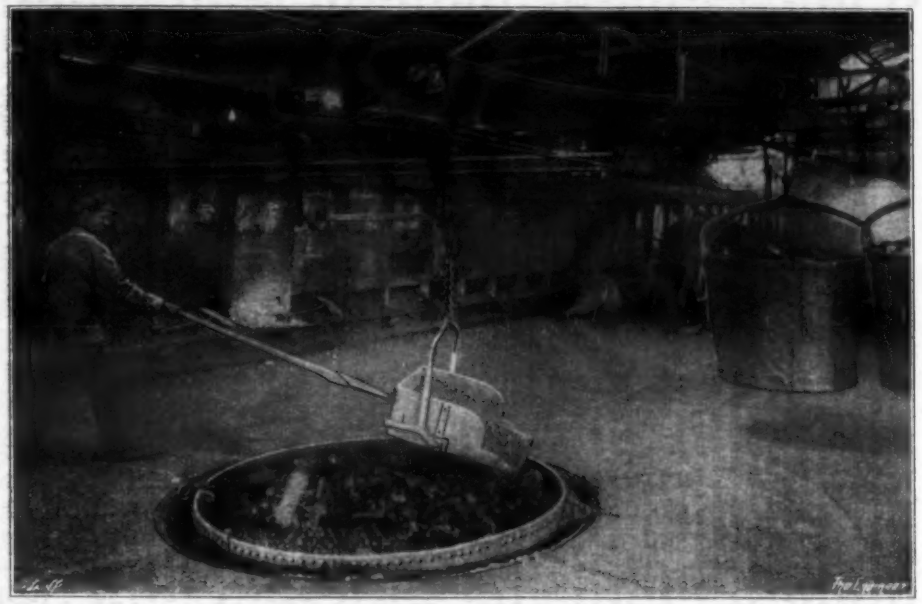

FIG. 11—MIXING CHARGE FOR BLAST FURNACE

FIG. 12—TAPPING A STEEL FURNACE

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THE ENGINEER.

APRIL 23, 1926.

The French Navy.

THE debate in the Senate upon the estimates for continuing the programme of naval construction revealed a sudden reawakening of the French to the necessity of having a strong navy. There is no secrecy about the influences that have brought about this revival of naval interest. The growing force of Italy, and recent declarations that its ancient control over the Mediterranean must be recovered, have compelled the French to review the situation in which they are placed by the possible supremacy of a rival power. The security of France is deemed to lie entirely in maintaining a perfectly safe communication with North Africa. The whole naval policy is based upon defending the Atlantic and Channel coasts mainly with submarines, torpedo boats, aircraft and land batteries, and in providing a powerful fleet of fast crusiers, in conjunction with underwater and aircraft, to insure supremacy in the Western Mediterranean. North Africa is regarded as a continuation of the mother country, and there must be no risk of that continuity being broken in time of trouble. The French do not look upon the Italian aspirations with uneasiness, but they feel that they cannot exist in the Mediterranean in a state of inferiority, and during the debate in the Senate there was a unanimous insistance upon the necessity of providing an adequate fleet. The French navy has only recently been emerging from a period of preliminary re-organisation. The old navy was obsolete after the war, and nothing had been done to replace lost and worn-out vessels. For nearly eight years there had been practically no designing and construction of new ships. When, therefore, it was decided to start upon the constitution of a new navy in accordance with a new naval strategy there was found to be a deficiency in technical progress and skill. Everything had to be started over again, and the Minister of Marine affirms that, while there were some mishaps and disappointments, the results obtained with the new ships have, in many cases, exceeded expectations. Through lack of sufficient inducement, officers, in an unduly large proportion, have resigned their commissions, and there is a notable falling off in the number of aspirants entering the naval colleges, with the result that, it is declared, there is a decline in the number of officers as well as of their general average efficiency. More encouragement means a greater expenditure, and every attempt to enhance the value of the navy is met by the difficulty of providing the necessary funds. Nevertheless, the Senate declared its intention of voting all the money that was required to raise the navy to the position it ought to occupy.

The existing programme was the first to be put in hand in pursuance of a definite strategical plan. It is true that a beginning was made in 1912 with a Naval Statute which co-ordinated the programme then agreed upon, and it is now urged that no time should be lost in adopting another Statute which aims at harmonising all the different services for naval defence, particularly in determining the command and distribution of the military and air forces for coast defence in association with the fleet. This organisation, of course, exists, but it is characteristic of French methods that it should be openly discussed in Parliament, and that all its details should be carefully laid down in what is practically a legal enactment. According to French ideas a Statute places the whole question of naval defence on a positive basis, and insures that the programme of naval construction is carried out according to the original plan, without subsequent changes that may destroy the homogeneity of the fleet. Past history shows plainly the evil effects resulting from successive Ministers of Marine imposing personal ideas that are not always in accord with those of the Conseil Supérieur de la Marine. That history is apparently not to be repeated. Except for a slowing down of construction during the short period of one Ministry the work has been pushed forward rapidly and is now being accelerated, with the result that by the end of June arrangements will almost certainly be made for putting another section of the programme in hand. Already 112,000 tons of light surface craft have been built or are under construction out of a total of 390,000 tons, and 26,000 tons of submarines out of 96,000 tons. As regards numbers, 32 vessels have been completed and 72 are under construction. An increase has already been made upon the original 60,000 tons of submarines and 360,000 tons of light surface craft, and it is practically certain that the total tonnage will be further augmented when that step is rendered possible by the financial situation. The development will be largely in the direction of submarines, which the French regard as indispensable for home and colonial defence, and they will never accept any proposal to suppress, or even restrict, their construction. As for capital ships, they are left in abeyance pending the completion of a new navy composed of an adequate force of light, fast and powerful cruisers. The capital ship does not come directly within the scope of the present scheme of naval defence, but the situation in the Mediterranean has involved changes that may give more importance to the capital ship in the future. Naval construction can only be developed and accelerated by a policy of concentration and of rigid economies. The Senate has avowed its intention of voting all the funds that may be required, but those funds will be obviously limited for a long while to come. Meanwhile, the money available must be spent to the best advantage, and the *rapporteur*, M. Raiberti, insisted again upon the suppression of some of the arsenals, the destruction of which he decreed when he was Minister of Marine. Socialist opposition prevented that being done, but the Senate agreed with M. Raiberti that the costly and practically useless arsenals must go, leaving only Toulon, Brest and Lorient. Proposals for suppressing arsenals and giving a larger proportion of work to private shipyards, which are now suffering from the effects of a severe depression, will certainly be brought forward when credits are asked for to permit of the next instalment of the programme being put in hand.

While satisfactory progress is being made with ship construction, the situation of the aircraft branch of the service is open to criticism. The coast defence with aeroplanes is well organised, but it does not come under naval control, and it is certain that seaplanes are less numerous and efficient than in some other navies. It is only recently that anything has been done with flying boats. There are at present ten squadrons of seaplanes and 214 machines, and in view of the troubles that have been experienced it is proposed to reorganise the service. To obviate failures a more rigorous system of reception has been imposed, with the result that many machines have been rejected. Aeroplane makers have so far lacked experience in seaplane construction. Official trials have proved more or less a failure, but the Under-Secretary of State for Aeronautics declares that great progress has been made recently, and that the forthcoming trials of seaplanes are likely to reveal a considerable improvement. On the whole, therefore, the French have reason to be satisfied with the results obtained by the methodical carrying

out of a programme which is providing them with an entirely new navy adapted to special needs, although the changed conditions in the Mediterranean may possibly necessitate some deviation from the original plan.

All-Steel Passenger Rolling Stock.

In May, 1904, the Board of Trade made a requirement that cars for tube and other electrically-operated railways were to be constructed of metal. Except on such roads the only steel passenger vehicles in regular use are the kitchen cars on the East Coast morning trains, which were introduced by Sir Vincent Raven in the summer of 1914. But a train placed in the Southport–Manchester service in December, 1913, had outside panels of steel. The home of the all-steel passenger train is the United States, where the first cars so built were some postal vans. On American trains the Post Office vehicles are always placed next to the engine, and the number of letter-sorters killed in collisions was so great that the United States Postmaster-General, about 1907, compelled the companies, as part of the mail contract, to provide all-steel postal vehicles. Steel passenger cars followed, and it is of interest to note that the reasons advanced, at the 1908 meeting of the Master Car Builders' Association, for their adoption were :—(1) The burning of wooden cars in wrecks and the frequent destruction of human life by fire ; (2) the splintering of the large wooden sills, &c., when the cars were wrecked, causing injury and death ; (3) the scarcity of timber suitable for sills, stringers, &c., and the threatened exhaustion of such material ; (4) in collision with steel freight cars, which were being introduced in large numbers, the passenger equipment was more liable to destruction than when wooden freight cars were employed.

None of the foregoing reasons has, however, accounted for the advent of the all-steel train into this country. Collisions here are rare—not even comparatively rare—and cases of telescoping less frequent still. We may appropriately recall the views expressed by Mr. R. W. Reid, the London, Midland and Scottish carriage and wagon superintendent and the designer of the present all-steel train, on this particular subject in his report to the Rome International Railway Congress in 1922. He said then, as reported on page 405 of THE ENGINEER of April 14th, 1922, that "the British railway management has rather concentrated its efforts on securing the safety of the line by improved methods of signalling and train control, and, by those methods, to prevent accidents happening." That the efforts indicated by Mr. Reid have been successful is seen in the fact that the only occasion of recent years where telescoping had serious results was at Abermule on January 26th, 1921. There have been collisions which were followed by fire subsequently breaking out in the wreckage. The most serious was at Quintinshill on May 22nd, 1915, but it was due primarily to live coal from derailed engines. The last such case occurred on September 2nd, 1916—nearly ten years ago—when, at Warminster, escaping gas was illuminated by a match struck by one of a search party. No ! the reasons that have led to this new line of policy in passenger rolling-stock construction are, in effect, mainly national in character. They are to be found in the desire of the London, Midland and Scottish Company to provide work for British manufacturers during the serious industrial stress they have been and are passing through. By using steel instead of teak occupation is found for British workmen in many directions. Then, by placing the order—in the present instance for 235 vehicles—with private builders, the work is being shared by several manufacturing areas. At the same time the travelling public is being provided with a fine type of roomy, comfortable, well-equipped coach, which will be specially useful for long distance, all third-class, excursion traffic. In this connection it should be remembered that the former Midland Railway—in the matter of rolling stock the predominant partner in the London, Midland and Scottish group—was the pioneer in catering for the comfort of the third-class passenger. The open type of car, with a central gangway, is particularly suited to the class of traffic for which these trains are built. They will be used chiefly by parties, which will be less liable to be broken up than they are in trains of compartment vehicles. The coaches, too, can readily be converted into restaurant cars when desirable by the attachment of a kitchen-car in the middle of the train. Since tables are provided in the cars the change can be made rapidly, and the whole train becomes available for meals.

Many of the preconceived notions generally prevailing as to all-steel passenger coaches bid fair to be dissipated. It is not possible to have a quieter or more smoothly running vehicle than those that were on the trial run last week. The fears that they will be too hot in summer and cold in winter are removed by the adequate means of ventilation provided ; no rattle or other irritating noise was observable and, certainly, there is nothing to offend the most fastidious taste in either the interior decorations or in the exterior. The fears often expressed in the past as to excessive deadweight appear to have been falsified, as the weight per car is only between 29 tons and 31 tons, and thus closely approximates to that of the ordinary bogie stock built in the Derby shops of the railway company. Improvements will, no doubt, be effected, and it is of interest to note that by placing the present order with four firms, so that each might submit stock built, in some respects, to its own ideas, the company will benefit by the ability to contrast slightly varying designs.

Limiting Stresses.

The recent meeting of the Institute of Metals furnished the occasion for an interesting discussion on the problem of the determination of the "limiting creep stress" for various materials when tested under tension at high temperatures. The result of that discussion must tend to leave the practical engineer who has to use such materials in his designs rather in the unhappy state of the patient when "doctors disagree." On the one hand, Messrs. Tapsell and Bradley, of the National Physical Laboratory, claim to have determined the "limiting creep stress" of certain materials when they have found that, under given conditions of load and temperature the creep is less than one ten-thousandth of an inch per hour. As they plot their data, the results suggest that at a very slightly lower stress there would either be no creep at all or the rate would be so slow as to make it negligible for practical purposes. On the other hand, Mr. R. W. Bailey, whose views were backed by Mr. Gough—also of the National Physical Laboratory—held that logarithmic plotting seems to show that no such thing as a true limiting creep-stress has been found in the tests made by Tapsell and Bradley. Mr. Gough suggested that a determination of the total creep after several hundred days would be required in order to ascertain whether the rate of creep had really fallen away from the logarithmic curve indicated by the tests at lower loads.

Quite apart from the disagreement of experts, which in itself is a healthy and useful thing leading to further fruitful work, we are thus obviously placed in a difficult position in regard to this matter of "creep stress." The situation is now somewhat similar to that of the "limiting fatigue stress" of certain non-ferrous metals, where logarithmic plotting of the results seems to indicate that in many materials a true "fatigue limit" has not been determined, even in tests which have lasted for a hundred million reversals, and that something of the order of several thousand million reversals may be required in order to settle the matter. Even at the high speed of 5000 reversals per minute, such a test would occupy many months, and although as a matter of research it might be undertaken in special cases, it is clearly not a method capable of wide utilisation. The determination of limiting creep stresses by means of tests lasting over hundreds of days is similarly a matter of great difficulty and impracticable, except for purposes of very special research. For fundamental purposes, of course, such formidable tasks will have to be faced, since these are questions upon which it is essential that we should have perfectly unassailable knowledge. Materials used in engineering service may well be called upon to resist a steady load at a high temperature for many hundreds of days, while in fast-running machinery the applied alternations of stress may run into hundreds, or even thousands, of millions. Meanwhile, however, the practical engineer needs to know how to utilise the materials with efficiency and safety. At first sight it would appear that his only safe and wise course is to apply, in all such cases, a "factor of safety," large enough to cover the possibility that the "limiting stress" so far determined may be too high owing to undue brevity of the endurance test applied. For instance, it would scarcely be suggested that under a stress of one-half the "limiting stress" found by Tapsell and Bradley, the material tested by them would fail within any reasonable period of time. The same consideration applies to the "limiting fatigue stress" as determined, say, by a test run over 100 million reversals. But this "factor of safety" would have to be added to the ordinary factor of safety used to allow for uncalculated or uncalculable stresses, defects of workmanship or material, &c., and, viewed in that light, it becomes a serious matter.

The difficulty is that in so many cases of modern engineering design, weight and bulk are themselves limiting factors. If an aeroplane engine, in the earlier days of aviation, had been designed with orthodox ample factors of safety, particularly in regard to the fatgue endurance of some of its highly stressed moving parts we should have had a highly reliable engine, no doubt, but one that could never have raised its own weight from the ground. For such reasons, the adoption of ample factors of safety is not the easy solution of the problem. Actually, it will have to be solved by the combined effect of two processes. On the one hand, the investigators will gradually determine the real fundamental physical properties which the engineer needs to know, and they will then, we feel sure, be able to arrive at some much shorter way of determining these properties for a given sample of material. Acceleration tests, we know, are apt to be dangerous or misleading, but only if they are applied without the full fundamental knowledge which we are here postulating as an essential foundation. Until that knowledge is available, however, only limited reliance can be placed on the determinations of "limiting stress," and the engineer must proceed tentatively, gradually gaining confidence by accumulated experience. The "trial and error" method of to-day is guided by experimental data which limit the range over which trial may reasonably be made and serve to avoid the risks of serious and rapid failure. Accumulated experience of service behaviour, however, can and no doubt will be used to complete the knowledge which experimental investigation over limited periods of time can afford. In such cases only the structure or the machine can really afford the opportunity for tests sufficiently long-continued to be conclusive. It is eminently a case where great results can be achieved by the close co-operation of the investigator and the practical engineer. Fortunately, there are many signs to show that such co-operation is possible to-day and that its value is appreciated by both sides.

Woodworking Machinery at Olympia.

Just as the agricultural engineering firms regard the annual Cattle Show as their own particular exhibition, on the ground that most people who are interested in live stock are also buyers of all sorts of agricultural tools, so have the makers of woodworking machinery come to regard the Building Exhibition, which is held every second year at Olympia, as the show at which to make a comprehensive display of all the latest woodworking machinery. For the builder—if we reckon by the volume of machinery that he buys rather than by the size of the machines—is the best all-round customer of these firms, better even than are the large saw mills. Machines, however, that are good for the builder are in nine cases out of ten equally good for everybody else who uses general purpose woodworking machinery. Thus the interest in these exhibits extends far beyond the building trade itself.

If we except large log sawing machinery, which none but a few of the very big builders have occasion to use, the display of woodworking machinery at the Exhibition which opened at Olympia on the 14th and remains open until the 28th inst. may be regarded as a very complete and comprehensive show of the latest improvements in these machines. Some fifteen firms are showing between them over 160 machines, and with three exceptions the makers are all British. In fact, the only two absentees among the well-known British firms are Ransomes of Newark, and MacDowalls of Johnstone.

While there is nothing revolutionary in the way of new inventions, the designs of the machines all round show a marked improvement since the last Exhibition two years ago. There are many strikingly new features in several of the types of sawing and planing machines, and more so still in the lighter joinery tools, particularly in mortising machines of the chain and hollow chisel type and in a number of the accessories to vertical moulders and shapers for rapid housing, recessing, dovetailing, &c.

Speaking generally, the makers of woodworking machinery in this country can be divided into two classes, those whose aim it is to keep abreast or ahead of the times, and those who content themselves with producing readily saleable machines at a moderate cost. Both classes are fully represented at this Exhibition. Competing with these latter are three

foreign firms; Guilliet and Sons, of France; the Danckaert's Woodworking Machinery Company, of Belgium; and Kirchner and Co., of Germany. Some of the foreign exhibits are of considerable magnitude, but there is nothing strikingly novel in the designs of any of the machines shown by the continental firms.

Among the dozen machines shown by Thomas Robinson and Son, Ltd., of Rochdale, are a new under-driven saw bench for rapid re-sawing, but readily convertible for use as a plain "push" feed bench. The feed of this machine is of what is usually known as the radial arm type. It differs very materially, however, from that used on the ordinary radial feed saw bench by the fact that the arm bearing the rollers is carried below the table so that there is no overhead gear. Apart from the advantage of this arrangement in keeping the table comparatively free, the whole of the feed gear can easily be swung aside to admit wide boards or when changing the saws. The vertical feed rollers are 10in. in diameter and the pressure is applied to them by a wire rope and weight attachment controlled by a foot lever by means of which the feed attachment can be rapidly adjusted to suit timber of various widths, while leaving both the operator's hands free for handling the work. This firm is also showing two of its latest four-side planing and moulding machines containing many novel improvements for facilitating access to the cutters for "jointing" or "tracking" purposes and improvements in the adjustments of feed rollers and pressures. The high-speed planer is fitted with an improved variable-feed gear of the Vee belt type. Another exhibit on this stand is a universal woodworker, which is capable of doing all the operations required in a small builder's shop with the exception of band sawing and irregular moulding.

In conjunction with their latest type of chain cutter and hollow chisel mortising machine, Thomas Robinson and Son, Ltd., are showing an entirely new tool which is capable of sharpening both the chain cutter and the hollow chisel. The mortise chain is sharpened by means of an ordinary emery disc, the chain being passed to and fro below the disc supported on a sliding sprocket. The amount of grinding is determined by a fine screw adjustment, whilst the correct pitch between cutting edges is ensured by a dividing head. The hollow chisels are ground by a revolving emery cone mounted on the other end of the spindle, and the square mortise chisel is presented as required to this cone by an ingenious form of holder with very fine adjustments, so that it can be readily and accurately presented at the required angle to the action of the emery cone. This contrivance entirely does away with the laborious and difficult process of hand sharpening which has been a drawback to the hollow chisel mortiser. As the bevel on all four sides of the chisel is on the interior surface, the process of hand sharpening requires much skill. This difficulty is obviated by this machine, which further ensures that the sharpening shall be regular all round the surface of the chisel. The chisel is presented to the cone in such a manner that one part of its interior surface, only, touches the cone at a time, and it is then rotated by hand, the holder maintaining it always in its proper position.

A complete set of joinery machines, including circular and band saws, planing and other machines, is being shown by Wadkin and Co., of Leicester. The most interesting of these exhibits are a new three-cutter planing and moulding machine, in which all gearing is enclosed and runs in oil baths, and a new mortising machine in which both the chain cutter and the hollow chisel are driven by a direct-coupled motor, thus obviating all belt slip and greatly simplifying the action of the machine. This machine is fitted with an automatic clutch, which stops the rotation of the tools as soon as they are raised from the work.

An interesting novelty on this stand is an electro-brazing apparatus, which is shown in operation. It is very simple and effective and shortens up the process of brazing band saws very materially. When the laps have been reduced to the required thickness and placed in position in the clamps the electric current heats them with perfect uniformity and the whole operation is completed in little over a minute. All danger from over or irregular heating is also eliminated.

Upon the stand of John Pickles and Sons, Ltd., of Hebden Bridge, are to be seen thirteen machines, including besides sawing and planing, mortising and tenoning machines, a number of modern sand-papering machines. The most novel machine shown is a turret head mortiser, the various arms of which carry different mortising tools, viz., two with hollow chisels and two with chains of different widths. Thus, four different types of mortise can be made by merely turning the upright head to the required position. Apart from the turret head this machine differs from any other mortiser by the fact that the tools have no vertical motion, the mortises being effected and regulated as to depth by a rising and falling table. The table is raised and lowered by power and is fitted with a quick-descending motion for use after the mortise has been cut.

Another interesting machine is a straight line edging saw. In this machine the circular saw revolves above the table and the work is carried under it on a series of travelling pads fitted to an endless chain, and is pressed down on to the pads by horizontal pressure rollers above the material. The action of this machine is from three to four times as fast as that of any of the ordinary saw benches for flatting or edging. As the action of the travelling chain determines the straight line of the saw cut, much of the work could be done without a fence, though a fence is provided as a gauge for the finished width of the plank.

Eleven machines are shown by J. Sagar and Co., Ltd., of Halifax, amongst them a straight-edger not unlike that just described. Other interesting machines on this stand are a heavy double gear roller feed planing and thicknessing machine, a "Premier" over-and-under planer, a semi-automatic chain cutter and hollow chisel mortising machine, a special type of builders' tenoning machine, and a four-cutter moulding and planing machine.

The greatest novelty on the stand of Haighs (Oldham), Ltd., is a new machine for haunching tenons and cutting wedges. The process of haunching involves two operations, viz., the cutting through the tongue of a tenon with the grain to any depth that may be required, and the cutting out of the wood which is left between the various saw cuts. The former is done by a row of saws on a horizontal spindle spaced apart by distance collars which determine the width of the haunch, and the cross-cutting by means of saws placed at right angles to the others. These cross-cut saws are small and their diameter is governed by the width of the haunches. These saws run on separate spindles mounted on a horizontal slide at the back of the machine, which has both longitudinal and transverse movements so that the saws may be set in any position for haunches of different depths. The wood to be haunched is fed up to the larger saws to the required depth of the cut, and then rapidly cramped on the table. The table with the wood on it is then raised by means of a lever on the right of the machine until it passes up to the position required for the cross-cutting saws to come into operation. Another interesting machine of totally novel construction is a roller fed belt sandpapering machine, intended to compete with the big drum sanders.

A firm which specialises in the smaller builders' plant is the Dominion Machinery Company, of Halifax. It is again showing the Super-Elliot woodworker, which, in spite of the admitted shortcomings of all combined joinery machines as far as rapid output is concerned, has of late years become immensely popular in small shops. It has periodically undergone considerable improvements, of which the latest is the substitution of a combined surfacing and thicknessing planing attachment for the former hand feed planing attachment. Although capable of doing all of the following operations, this machine is extremely compact and simple:—Ripping and cross-cutting up to 26in. wide by 6in. thick; housing, trenching, boring, planing, surfacing, thicknessing, moulding, mitre cutting, and rebating. All these operations are driven from one motor fixed to a pivoting head so that it may accommodate itself to driving the various operations as required. This arrangement has the further advantage of obviating the turning of the wood when changing from ripping to cross-cutting. The planing portion of the machine will accommodate boards of any dimension up to 16in. wide by 9in. thick.

One of the largest stands in the Exhibition is that of Thomas White and Sons, Ltd., of Paisley, who formerly were best known as specialists in bobbin machinery, but have come very much to the fore of late years as manufacturers of general purpose woodworking machinery. The most formidable and interesting machine shown by them is a high-speed four-side planing and moulding machine. Among their other machines are sandpaperers, surfacing and thicknessing machines, a straight-line edger, a new vertical spindle moulder with the motor direct-coupled to the spindle, and an automatic-action hollow-chisel mortiser driven by a cone clutch and dealing with stuff up to 12in. by 6in.

Woodworking machinery is also shown by Dening and Co., of Chard, Somerset; Perkins and Co., of Leeds; and A. Cooksley of London.

Literature.

Oil and Colour Chemistry Monographs—The Chemistry of the Drying Oils. By R. S. MORRELL and H. R. WOOD. Price 21s. net. *Volatile Solvents and Thinners.* By NOEL HEATON. Price 15s. net. London: Ernest Benn, Ltd. 1925.

THE first of these volumes contains a condensed account of the origin, extraction, properties and uses of fatty oils known as drying oils.

A drying oil is an oil that, when exposed to the air, especially if in thin films, absorbs oxygen and changes into a tough elastic solid (linoxyn). Among the many drying oils known, numbering about three score, less than a dozen are of commercial importance. Of them, linseed oil is pre-eminent in general utility, and is employed in far larger quantities than is any other drying oil. China wood oil or tung oil is also used to a considerable extent.

The principal use of drying oils is in the manufacture of paints. Ordinary paints contain a finely divided solid pigment and a drying oil, the mixture being thinned in consistency by the addition of a suitable volatile solvent of the oil, such as turpentine. After application of the paint, the volatile solvent evaporates, leaving a sticky film consisting of a suspension of the pigment in the drying oil. Subsequently the film absorbs oxygen and becomes hard, dry and impervious.

Linseed oil also finds very important applications in the manufacture of linoleum and floorcloth, electrical insulators, and patent leather. These applications are concisely described by the authors in an interesting chapter.

The first three chapters of the book are devoted to chemistry. The naturally-occurring oils are mixtures of complex compounds. Much research work has been carried out in recent years by chemists with the object of elucidating the difficult problems connected with the composition of the oils, the chemical constitution of the individual components, and the explanation of the so-called "drying" properties. Although considerable progress has been made, the subject is still very obscure; here, evidently, is a wide field for investigation in which future workers may dig with the certainty of reward.

In other chapters the authors describe the methods of extraction of the oils from the plant seeds and processes for refining the oils and for improving their drying qualities. Chapter IX., the last chapter, contains a brief account of the methods used for testing and analysing drying oils, and for the detection of adulterants.

Mr. Heaton's book is concerned with the solvents that are used in the paint and varnish industries. The most important use of the solvents is for thinning paints and varnishes to the correct consistency for application by the brush or spray. For this purpose much care in selection is necessary, for the thinners must not evaporate too rapidly or too slowly; neither must they leave an oily residue in the film.

The book contains nine readable and informative chapters. The solvents described include petroleum hydrocarbons, coal tar hydrocarbons, turpentines, alcohols, ketones and ethers, esters, hydrocarbon chlorides, and carbon disulphide; the origin, the method of production, the properties and the uses of each substance are clearly indicated. In the last chapter certain general considerations bearing on the subject are discussed; they include specifications, storage, recovery, physiological action, solvent action, viscosity and miscibility.

Mr. Heaton opens his preface with what amounts to an apology for writing the book. He need not be so modest, for apart from its general excellence, which none will dispute, the volume is undoubtedly useful in that it fills a gap in the literature of chemical technology.

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Gayer's Acreage Tables. Second edition. By A. E. Gayer. London: The North London School of Surveying, 9, Heath Hurst-road, N.W. 3.

Elementary Electrical Training. By O. R. Randall. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C. 2. Price 5s. net.

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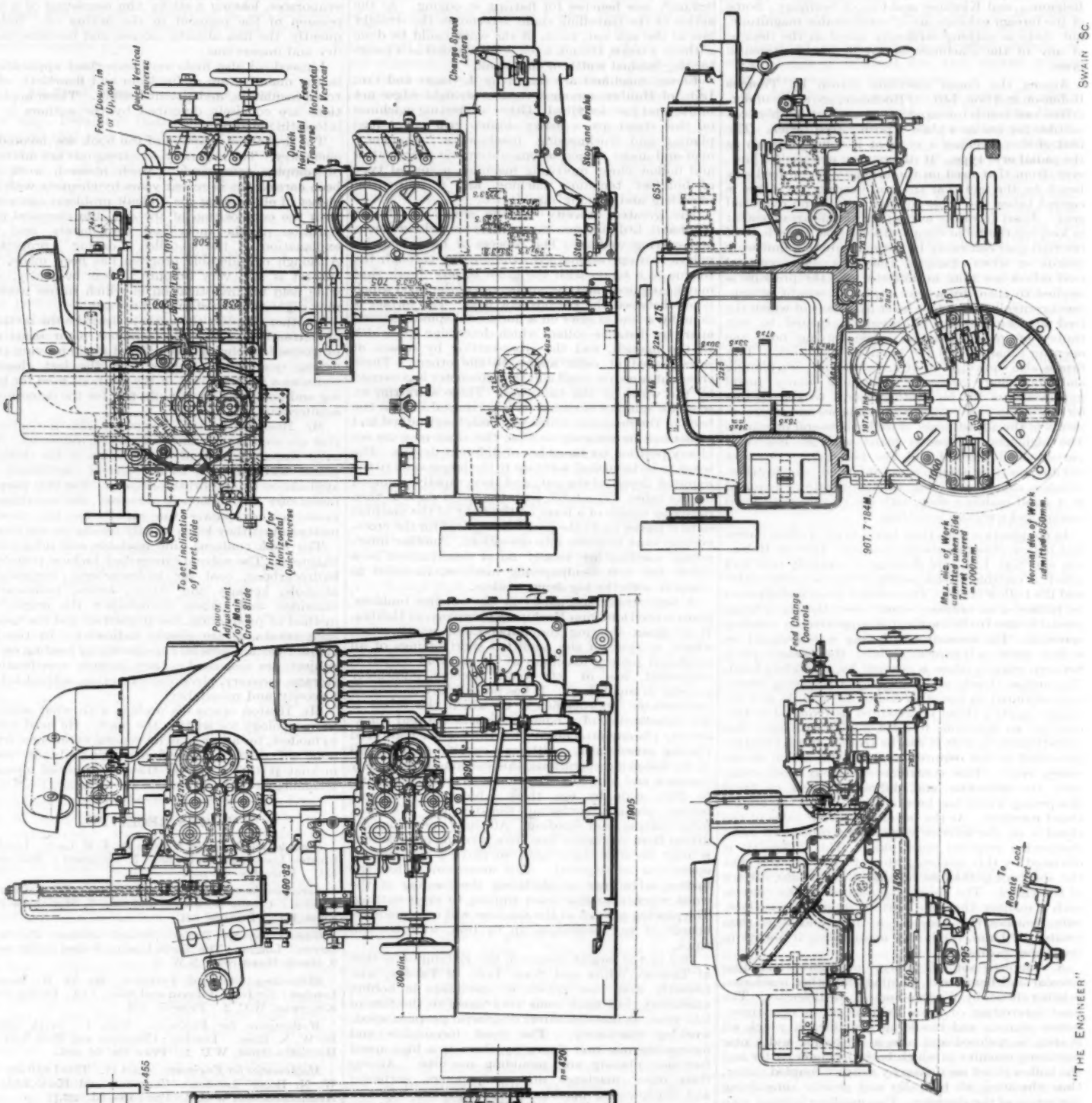
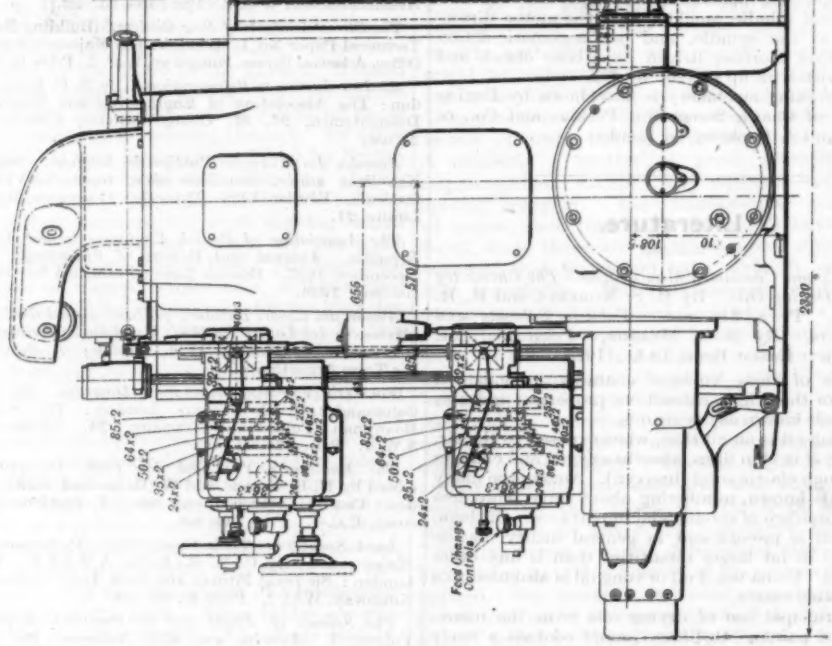
VERTICAL BORING AND TURNING MILL


Feed Down, in or Up, out
Quick Vertical Traverse
Feed Horizontal or Vertical
Quick Horizontal Traverse
Change Speed Levers
Stop and Brake
Start
To set inclination of Turret Slide
Trip Gear for Horizontal Quick Traverse
Max. dia. of Work admitted when Side Turret Lowered = 1000mm.
Normal dia. of Work admitted=650mm.
967. 7 1184
Power Adjustment of Main Cross Slide
1905
Feed Change Controls
To Rotate Lock Turret
"THE ENGINEER"



SWAIN Sc.

A Vertical Boring and Turning Mill.

THE "mono-pillar" vertical boring and turning mill illustrated herewith is the product of the Schiess-Defries Company, of Düsseldorf. We were recently invited to inspect the machine at the new establishment in Charles-street, Hatton-garden, London, of the Selson Engineering Company, Ltd., the agents in this country for its sale. The Schiess Company is well known for the production of very large-sized boring and turning mills, but the machine illustrated is not unusual in any of its dimensions. It is the second of a series of four designs, having face plates ranging in diameter from 25in. to 47in. It has a face plate diameter of 31½in., and can turn up to a maximum diameter of 39½in.

The machine as illustrated is arranged for a belt drive, but as we saw it at Messrs. Selson's establishment it was being driven by a 15 horse-power motor mounted on a bracket on the left hand of the column or pillar. It will be noted that the main frame consists of a single pillar-like casting, to which the stool for the face plate and other parts of the framing are bolted. On the front, the pillar is formed with three sets of vertical guiding surfaces, with which engage the main cross-slide and a slide for a side turning tool. The main cross-slide supports a horizontally moving carriage to which is affixed a guide base for the main turret slide. Normally, the guide base is clamped vertically to the carriage behind it, but it can be fixed at any inclination, against a graduated scale, for taper turning or boring. The main cross slide, it is worthy of note, is not counterbalanced for its vertical movement, applied by power, is for quick adjustment purposes only. Vertical feed of the main turret is obtained by movement of the turret slide on its base. The turret slide is accordingly balanced by a counterweight. In the case of the side-turning arrangement, quick adjustment and feed in the vertical direction both involve movement of the slide and all its attachments, and accordingly the whole is counterbalanced.

The main turret is provided with holes for five tools, while the side slide carries a box capable of holding four tools. Five stations are arranged for the main turret, any one of which is reached by rotating the turret on its central pin by means of the hand wheel and worm gearing indicated in Fig. 1. This worm gearing is thrown into engagement when the hand wheel is pressed home on its axle over towards the left. If the hand wheel is pulled slightly towards the right, the worm gearing is disengaged, and rotation of the hand wheel then causes the turret to move horizontally outwards on its central pin, through a short distance away from its slide, which movement is sufficient to disengage the turret from its locking pin. The turret can then be rotated to the station required, and locked by moving it back again. The main turret tools, it will be understood, are employed for turning, facing and boring. The side turret tools are used for turning and facing.

Starting and stopping of the face plate motion is controlled from a double foot lever at the right of the stool. Twelve face plate speeds ranging from 5½ to 85 revolutions per minute are obtained by means of two levers, the upper lever having three positions in a straight slot and the lower having four in a double or gate slot.

A slow power adjustment of the main cross slide on its vertical guides is controlled from a long lever lying at the rear of the pillar near the top. This motion, as already stated, is not used to give vertical feed to the main turret, nor is it required to give quick power traverse to the turret slide, when, for example, the tool has to be moved vertically across some portion of the work on which machining is not to be done. At the right-hand end of the main cross slide, a group of three similar levers and a fourth lever will be seen in Fig. 1. The fourth lever has three stations, and determines whether the feed applied to the tool in use on the main turret shall be horizontal or vertical or out of action. The uppermost of the three similar levers completes the discrimination, one position giving downwards or inwards feed, and the other upwards or outwards feed. The quick traverse of the carriage on the cross slide or of the turret slide on its base is controlled by the two remaining levers, one of which gives quick traverse up or down, and the other quick traverse in or out. These two levers are spring-controlled in such a way that they are active only so long as the operator maintains force on them, and are so set as to call for natural movements. For example, to traverse the carriage quickly inwards, the operator exerts pressure on the lowest lever in the direction of the required motion and stops the movement by releasing the pressure. Automatic trips are provided for the quick traverse in both directions in order to avoid mishaps caused by the operator neglecting to remove his hand before the parts reach the limit of their movements.

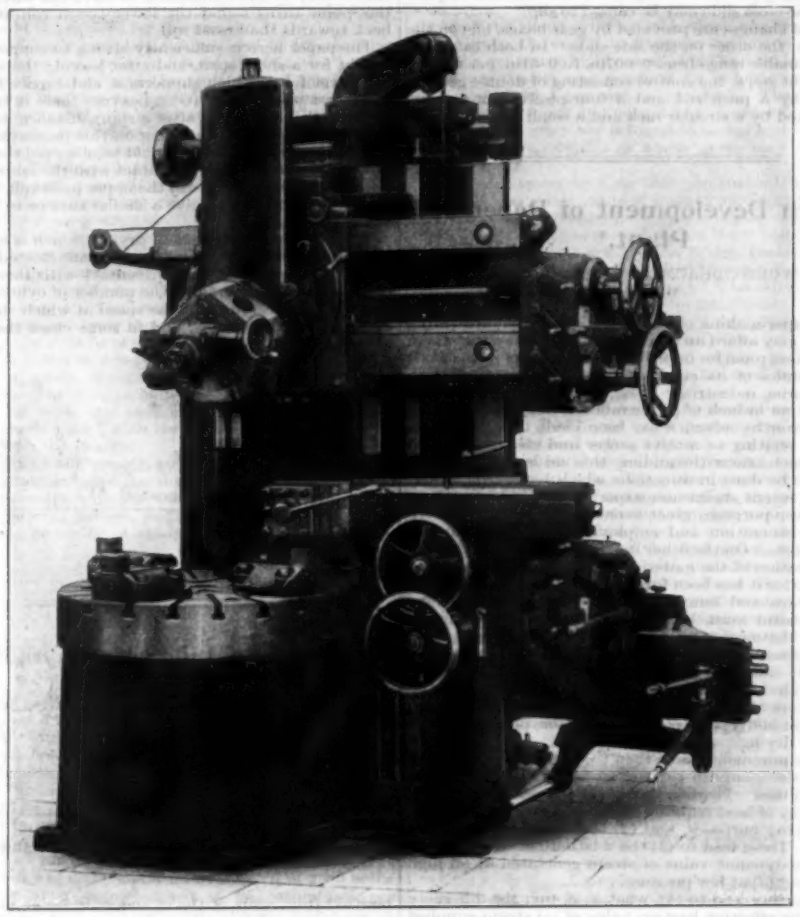
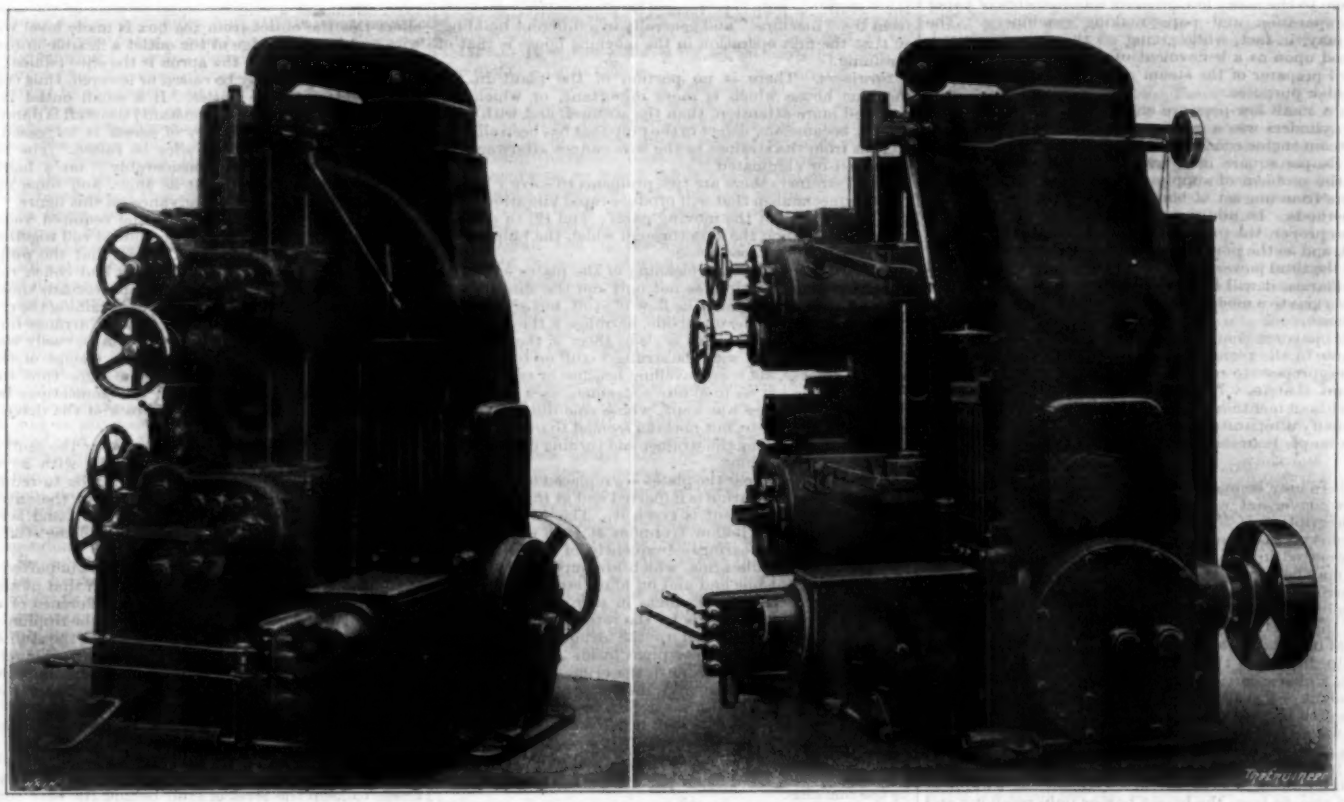


FIG. 1—31½in. BORING AND TURNING MILL



FIGS. 2 AND 3—SIDE AND REAR VIEWS OF THE MACHINE

The arrangement is even more striking in the case of the side turret. For example, to raise this turret and its slide, the operator in effect lifts the whole by applying a slight lifting effort to the middle lever, and lowers it by exerting a slight depressing effort on the same lever.

Provision is made to prevent the feed and quick traverse

being engaged simultaneously. In addition, it is arranged that no feed can be applied unless the face plate is running. Additional details affecting the ease of control of the machine are to be found in a foot brake provided to stop the rotation of the face plate quickly and a brake controlled from a lever on the carriage of the main cross slide, whereby a clutch in the drive for the slow adjustment of the cross slide may be caused to slip.

The feed changes are provided by gear boxes, one on the main slide, the other on the side slide. In both cases the feeds obtainable range from 0·007in. to 0·31in. per revolution in eight steps, the control consisting of double gearing operated by a push rod and a four-position in-and-out rod operated by a circular rack and a small knurled knob.

Modern Development of Paper-mill Plant.*

By W. WORBY BEAUMONT and LESLIE N. BURT, Members.

THAT paper-making is one of the oldest manufacturing industries may afford an explanation of the fact that there has been more room for improvement in some of its methods and economics of its conduct than in the more modern manufacturing industries.

There is no branch of paper mill development in which more noteworthy advance has been made in recent years than that relating to motive power and steam uses, and yet in which, notwithstanding this advance, so much remains to be done in directions which have been adumbrated by recent steam user experience.

For power purposes great economic advantages derive from the generation and employment of the steam at high pressures. On the other hand, for nearly the whole of the preparation of the materials for making paper and for drying it after it has been formed, steam at comparatively low pressures and temperatures is required. This low-pressure steam must be provided whatever the motive power for the mechanical operations. Generally reciprocating engines are used, although turbines have been numerously adopted. In any case the steam engine of whatever kind must release the steam it uses, as steam, and therefore at a temperature approaching that of much of the heat-conveying requirements for preparation as well as for drying.

These requirements have then to be considered in their relation to economy in the cost of fuel for steam generation for all uses. There is then: (1) the relation between the quantity of heat required for (*a*) preparation purposes, (*b*) for drying purposes, and (2) that required for power purposes. These lead to (3) the relation between the cost and thermodynamic value of steam generated at (*c*) high pressure and (*d*) at low pressure.

These further lead to (4), what is, if any, the difference between the effective heating value of (*e*) steam supplied for heating from a continuous source, as from a separate boiler, and flowing or moving steadily as caused only by loss of heat by condensation; and (*f*) steam supplied under rhythmic impulse as exhaust steam from an engine. If the generation pressure is raised there is a continued increment of dynamic value per thermal unit added in generation economically utilisable up to pressures of about 300 lb. From engines using these pressures steam may be taken by one or other of the extraction methods and passed therefrom to the many low-pressure requirements of paper pulp preparation and paper-making machinery. The engine may, in fact, while giving off the power required, be looked upon as a benevolent obstruction in the steam pipe and preparer of the steam and heat required for the many other purposes.

With a small low-pressure engine steam supply to the drying cylinders was a comparatively simple matter, but when steam engine economy demands a pressure of 150 lb. to 200 lb. per square inch and drying cylinders 3 lb. to 10 lb., the problem of supplying both engine and drying cylinders from one set of boilers involves the adoption of new methods. In addition to the driving of the paper machine proper, the preparation of the pulp must be considered, and as the power required for this may frequently exceed the total power required for the paper machine and its auxiliaries, it will be realised that the planning of the power service to a modern paper mill is a matter of primary importance.

In this paper it is impossible to deal even cursorily with the whole of the plant in everyday use, and the authors therefore propose to refer only to the machine house and the plant therein. The preparation of the pulp would itself, without mention of the numerous auxiliary processes, fully justify a separate paper, indeed beating alone would furnish ample material for a lengthy treatise.

As there may be many members of this Institution who are not conversant with the working of a paper mill, a brief description of the paper machine as generally constructed is necessary in order to explain the changes which have occurred in recent years and where future developments may be expected.

Referring to the diagram Fig. 1, at the extreme right are the strainers (A) or knotters, as they are more generally called, the function of which is to free the pulp from any particles unsuitable for paper making. From the knotters the pulp flows into the breast box (B) and thence on to the wire which is carried at this point by the breast roll (C), the amount of "stuff" passing determining the weight of the sheet to be produced.

The wire (D) is an endless band of woven wire cloth, the meshes of which must be open enough to allow the superfluous water to escape and yet fine enough to retain the fibre and "filling" carried with it. Below the wire, near the end remote from the breast box or pulp receiving and distributing box, are the vacuum boxes marked (E) in the diagram. A considerable quantity of the water leaves the pulp during its journey on the wire, and the purpose of the vacuum box is to extract as much as possible of that still remaining. In fact, it is correct to speak of "stuff" on the wire before it reaches the vacuum box and "paper" after it has passed over it. After leaving the vacuum box or boxes (modern machines are provided with more than one) the wire carries the paper through the couch rolls (F). The purpose of these is still further to dry or reduce the wetness of the paper, and by the moderate pressure exerted by the rolls to consolidate and strengthen it so that it may be in fit condition to leave the wire, which at this point turns round the lower couch roll and travels back towards the breast roll.

The paper here is sufficiently strong to support its own weight for a short span, and after leaving the wire meets the "wet felt," which supports it and carries it through the "first press rolls" (G). Leaving there it travels forward on the felt and is, after a short distance, transferred to a second felt, and travelling on this passes through the second press rolls (H). It should be observed that the side of the paper which was in contact with the felt in the first press is now in contact with the upper press roll, the object of this change being to give a similar surface to both sides of the sheet.

The next process is that of drying, which is effected by passing the web over a number of steam-heated cylinders (K), the paper being held in contact with them by felts as shown in the diagram. The number of cylinders varies considerably according to the speed at which the paper is made and its substance, and in some cases the felts are

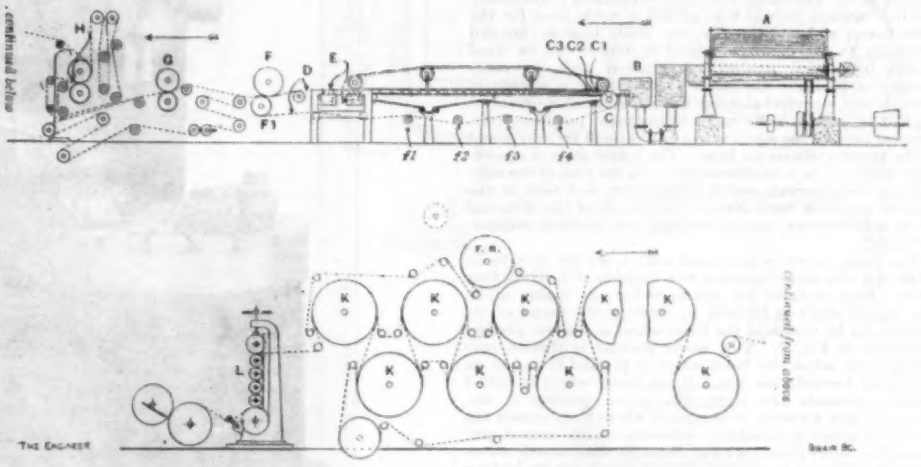


FIG. 1—DIAGRAM OF PAPER-MAKING MACHINE

omitted from some of the cylinders in order to allow the vapour given off from the web to escape freely.

Before travelling over the final cylinders the paper in some machines passes through a pair of smoothing rolls, the purpose of which is to obliterate the marks of the felt, which would otherwise be seen on the surface.

On leaving the drying cylinders the paper is taken to a stack of calender rolls (L), which may be said to complete the process of manufacture by burnishing and consolidating the surface. It is then wound in rolls ready for transport to other processes or to the printer. The preparation of the "stuff" or pulp is performed by plant entirely separate from the "machine" and generally in a different building, so that the first operation in the machine house is that of straining.

Strainers.—There is no portion of the plant in the machine house which is more important, or which has received more attention, than the strainer, and with good reason, because any defect in the pulp that has been allowed to pass from the strainer to the wire cannot afterwards be corrected or eliminated.

In all strainers there are two problems to solve: (1) To provide mechanism that will produce rapid vibration without undue wear of the moving parts; and (2) to provide means for keeping the slits through which the pulp passes clean and unobstructed.

In all flat strainers the cleaning of the plates sooner or later required attention, as not only did the slits become choked, thus diminishing the flow of stuff, but strings and hanks collected on the underside, harmless if they retained their position, but fatal to a clean sheet if they became detached and flowed with the strained stuff on to the wire. Various devices, such as travelling brushes or rakes or the rocking of the vat as in White's strainer, were tried, and in some mills a boy was kept, whose sole duty it was to keep the plates clear, but nothing seemed to overcome the necessity for stopping the strainer and turning up the plates for a thorough washing.

In Wandel's strainer the plates are replaced by a strainer drum, to which vibration is imparted and at the same time a slow rotary movement is given it. The strainer drum is provided with a hollow trunnion at each end. These trunnions rest in bearings—frequently of white metal—formed in the cradle arms, which are supported in open hinge bearings at one end and on blunt steel chisel points at the other. The chisel points in turn rest on ratchet cams on the shaft, and it is by the rotation of these cams that vibration is imparted to the drum. Cleansing of the slits is effected by spray pipes inside and outside the drum, the jets from which flush the orifices and eject any obstructions, the water and dislodged particles being collected by fixed troughs or catchers inside the drum and dealt with elsewhere. The stuff is delivered into the drum by pipes through the trunnions. It passes through the slits in the drum plates into a shallow vat and thence over the sill into the delivery trough and so to the breast and to the machine.

The disadvantages of the Wandel type strainer are found in its noisy working, and the fact that any dirt fine enough to pass through the slits can pass with the screened stuff on to the wire. More modern rotary strainers have the flow of stuff in the reverse direction; that is, the unscreened stuff enters the vat and flows upward and sideways through the slits into the drum, leaving it through the trunnions. This arrangement allows dirt and strings to settle at the bottom of the vat, from which they are periodically removed. These "inward-flow" strainers may be designed and are made in various forms and methods of operation.

The "Wet End."—On leaving the strainers the stuff flows into the breast box and thence to the wire of the machine, and it is on this that the transformation from pulp or stuff to paper commences, by the extraction of the superfluous water and by the "felting" of the individual fibres. To induce "felting" a rapid sideways reciprocating motion is given to the wire, by pivoting the forward ends of the frames on which the rolls supporting the wire are carried and rocking the whole rapidly backwards and forwards. The mechanism for this is called the "shake," and must be capable of regulation so as to prevent too much water being dropped in the process and yet leave sufficient to permit intermingling of the fibres. Regulation is also required for other reasons.

With slow-speed machines, for which one strainer is sufficient, the design of the breast box is a simple matter, but in modern high-speed machines, fed by six or eight strainers and running at a speed of 600ft. to 800ft. of paper per minute, great care must be taken to obtain a flow of pulp from the box at a velocity as nearly equal as possible to that of the wire and flowing at an even depth across the whole width.

The flow must not be so violent as to cause excessive rippling or the formation of the sheet will be disturbed. If the velocity of the stuff exceeded that of the wire, it would make it difficult for the water to pass through the interstices, and the impetus of the flow would nullify the action of the "shake," so that the individual fibres would not interweave, but would arrange themselves in straight lines, thus diminishing the strength (widthwise) of the sheet.

The breast box has a dual function; it must receive the output of several strainers from a common duct and provide a transition stage whereat the flow changes to a wide even stream at a velocity equal to that of the wire. To effect this the outlet from the box is made level with the wire and from the edge of the outlet a flexible apron overlaps the wire. Above the apron is the slice (sluice), which is made so that it may be raised or lowered, thus contracting or enlarging the outlet. If a small outlet is given (the flow to the box being constant) the stuff is dammed up by the slice and the velocity of egress is increased, while the converse occurs if the slice be raised. The head of pulp in the box varies considerably; on a high-speed machine it may be as great as 48in., and some machine makers advocate a further advance on this figure.

Another method of obtaining the required velocity is by raising the frame carrying the breast roll together with the wire and its supporting rolls, so that the pulp flows downhill towards the vacuum boxes and couch roll. As far as simplicity of construction is concerned, there is no doubt that the breast box method of obtaining the requisite speed is superior, as it is far more easy to arrange for variation of head in the box than to provide an easily workable gear for lifting the very considerable weight of the wire frame and its apparatus, and at the same time to avoid as far as possible disturbance of the connections between the vacuum boxes and their pumps and the drive to the shake.

Another point to be considered is that the stuff during its whole journey on the wire is parting with its watery constituent, and the effect of this must be to reduce the speed of the main body, first, because of the entraining action of the water passing through the wire, and, secondly, because of the increasing "stickiness" of the stuff as the watery content diminishes.

By whatever method initial velocity is imparted to the stuff at entry upon the wire, it is certain that at the commencement of its journey there is a difference of rate of travel between the stuff and the wire, as the rippling shows, and here is a problem:—How to regulate the stuff so that the flow shall be at the correct speed to allow as much water as possible to escape and at the same time allow the stuff to remain limpid enough to allow the fibres sufficient freedom to "felt" under the influence of the shake. This appears to be one of the questions that are not settled by theory or advised upon in text-books, and is therefore wisely left to the skill and judgment of the paper-maker. Many forms of regulators have been proposed and tried, to keep the level of stuff behind the slice constant, but the simplest thing seems to be to allow more stuff than is needed to flow into the box and return the surplus to the stuff chest over a weir the height of which is adjustable.

The Wire.—The term "wire" is a very meagre description of one of the most important and perhaps the most delicate members of the whole machine, and one in which a vast amount of skill and craftsmanship is concentrated, although disguised by its simple appearance. In the early

* The Institution of Mechanical Engineers, April 16th. Abridged.

days of the paper machine the "wires" were woven on hand looms and the material was generally an alloy of copper. In modern practice phosphor-bronze wire is largely used, and nickel alloys have been tried in the hope that their superior wearing quality would ensure longer life; each maker doubtless pins his faith on his own special alloy. The life of the wire is not a long one in high-speed news machines, possibly thirty days would be a fair average; whereas on a slower speed machine making a better class of paper, three times this life is obtainable. The cost of such a wire, say, 80ft. by 230in. wide, would be approximately £80, and the scrap value, when its short but active life is finished, not more than £10. Nevertheless, when it is remembered that such a wire has actually made more than 100 tons of newsprint in twenty-four hours, it will be appreciated that the wire cost per pound of paper is less than the one-three hundredth part of a penny.

Part of the deterioration is due to the action of chemicals employed in the preparation of the stuff and part to the strain and friction to which the wire is necessarily subjected. It is imperative, therefore, for the engineer to take every precaution against such losses from mechanical sources. The employment of ball bearings, especially those designed for self-alignment, would seem highly desirable, but although these would be quite satisfactory for ordinary running conditions, the difficulty of keeping up a sufficient coating of grease to prevent the water from the stuff—and from the hose pipe of the machine cleaner—attacking and pitting the polished steel surfaces, has prejudiced many machine makers against them. Opinions differ widely as to their use, and more than one well-known firm has found it possible to provide proper protection so as to ensure a satisfactory length of service. The Laurentide machine with a wire 166in. wide travelling at 1000ft. per minute is running successfully with all its tube rolls carried in ball bearings.†

One leading maker of ball bearings has been experimenting with stainless steel in order to overcome this difficulty, but the authors have not yet heard of any mill where they are in use. Up to the present it has not been found necessary or practicable to drive the rolls independently of the wire, but it may be that as the width of machines increases—for the tendency appears to be towards wider machines rather than increased speeds—much heavier rolls being required, some method of driving, either friction bevels or endless rubber belts with intervening jockey pulleys, may be introduced in order to lessen the load driven by the wire.

The vacuum boxes (E), Fig. 1, are probably responsible for more damage to the wire than any other piece of mechanism in its circuit. A vacuum is produced in the boxes either by a pump or an ejector and it follows that, as the wire passes over the top of the box, it is deflected downward under the influence of the vacuum. In early slow-speed machines it sufficed to use one or two boxes, but in a high-speed modern machine six or eight will be required, and the wire will be drawn down at each box and lifted again as it passes over the edge. Increase in the number of boxes allows a lower vacuum to be employed and thus tends to lessen the deflection of the wire. Needless to say, the effect of the vacuum is more severely felt if the wire be allowed to get clogged and dirty. The vacuum box may be made of metal or of wood, but almost invariably the top is faced with wood—mahogany for choice—and the friction between the wire and the wood is destructive to both. Attempts have been made from time to time to introduce rollers to take the place of the wood facings, but so far the results have not given satisfaction.

After passing the vacuum boxes the character of the sheet shows a marked change, and at this point may be said to have become paper; in fact, the change in character is plainly shown by a clearly defined line across the web as it moves over the vacuum box. The next operation is performed by the couch rolls (F F), Fig. 1, the purpose of which is to squeeze out as much water as possible in the same way as a washerwoman passes a cloth through a wringer. The lower roll is generally made of cast iron covered with brass, while the upper has a felt jacket. Formerly these were made of wood on metal centres. It should be observed that the upper roll is not directly above the lower, but lies nearer to the breast roll, the object being to meet the paper and squeeze out as much water as possible through the wire before it passes between the two rolls and receives the full pressure. The upper roll is carried in bearings in pivoted arms to which pressure is applied by a system of weights and levers, while the ends of the arms opposite to the roll bearings have screw gear for adjusting the pressure and to swing the roll clear when changing the wire. In some modern machines, especially in the United States, the couch rolls are dispensed with and a suction roll used in their place.

In considering the advantage gained by the use of the suction roll as auxiliary to the suction box it must be remembered that in high-speed machines, running between 800ft. and 1000ft. per minute, the time in which the stuff on the wire is exposed to the influence of the vacuum is exceedingly short. In a machine running at 800ft. with eight boxes the exposure is only half a second. Assuming the exposed surface of the boxes to be in all 80in., to obtain a corresponding suction surface in a roll the diameter would need to be, say, 100in., as only one-quarter of the circumference can conveniently be utilised.

The intensity of the vacuum required depends on the class of paper in course of manufacture, the wetness of the stuff, the state of the wire, clean or foul, the speed of the machine and the idiosyncrasies of the paper-maker. It may range from ¼in. to as high as 12in. (mercury), but a wide variation in running the same class of stuff generally indicates that something in stuff or machine requires attention.

The vacuum can be created in various ways, by steam ejector, syphon discharge, or by plunger pump, but modern practice appears to favour rotary pumps of the geared or drum type, as these are quiet in running, require little repair, and produce a steady vacuum. In old slow-running machines the vacuum pumps were small and required little power to drive, but in a modern news machine making, say, 75 to 80 tons of dry paper every twenty-four hours the need is very different. It may be assumed that 20 per cent. to 30 per cent. of the water content of the stuff, as it flows on to the wire, may be removed at the suction boxes or roll, so that with stuff having 98 per cent. of water—some authorities take a higher percentage—the pump must be capable of dealing with 7000 to 10,000 gallons of water (at the lower output) per hour. The removal of the entrained air naturally requires more power than the removal of the water. On a modern machine of the output above mentioned probably 70 to 75 horse-power would be required for the pump.

The couch rolls complete the wet end of the machine, for at this point the "making" is completed; the "stuff" has become "paper" and the remainder of the progress through the machine is devoted to "finishing." It is beyond the scope of this paper to mention all the details of the machine, but before leaving the wet end it is necessary to consider one point which determines the principle of its construction and involves the designer in fresh complications as new demands arise for speed or width. The wire is made endless, and that apparently insignificant detail makes it necessary that the running gear of the wet end, breast roll, tube rolls, carrier rolls, suction boxes, &c., shall be removed each time the wire is changed.

In the older machines of narrow width and infrequent changes of wire it was more a work of muscle than brain, a 50in. by 2½in. tube roll was easily lifted and the lower couch roll was not more than a two-handed job. To-day, now that tube rolls have increased to 240in. by 9½in., the work has a different aspect, and every possible device to facilitate a quick change and accurate replacement is imperative. The wire is joined together by stitching or soldering, or both, and care must be taken to obtain a perfectly smooth joint with the meshes as near as possible uniform with the original.

To minimise the time required to change a wire the machine designer aims at making all removable parts easily replaceable with the minimum of labour and providing registering devices, so that each may be re-erected without the necessity of readjustment.

(To be continued).

† Two 166in. news machines, built by the Dominion Engineering Works, Lachine, Que.

American Marine Oil Engine Trials.

THE first marine oil engine to be built by the Worthington Pump and Machinery Corporation, of Buffalo, for the United States Shipping Board has now completed the official bench trials, and the following are some of the results taken from reports of the trials which we have received from the builders through the Worthington-Simpson Company, Ltd., of London. An illustration of the engine was given in our issue of January 1st and a description of the design of the single-cylinder experimental unit will be found in THE ENGINEER for October 3rd, 1924. The engine tested was designed for a total output of 2900 brake horse-power at a normal speed of 95 revolutions per minute. It has four 28in. diameter cylinders with a piston stroke of 40in. The United States Shipping Board's test specification called for a continuous run of thirty days at the full rated load and speed, to be followed by a six hours' test at 10 per cent. overload at the same speed, and a further four hours with a 10 per cent. increase in mean effective pressure and a 5 per cent. increase in speed. These trials were to be followed by periods of six hours at three-quarter load, four hours at half load, and two hours at quarter load, with a one-hour run astern and one hour of manœuvring tests. For the thirty days' run a 1 per cent. tolerance in load was allowed and three revolutions speed variation, whilst a total of 2 per cent. of the total test time was allowed for adjustments not vital to the engine's performance.

The trials were begun on February 2nd and were completed on March 4th, after which the overload and other trials, including the astern test, were run continuously, the total testing period during which the engine was running being thirty-one days. When the engine was shut down at 5 p.m. on March 5th it was left untouched under observation until 9.30 a.m. the next morning, when the manœuvring trials were begun. It was shut down for 16½ hours in cold weather with the outside air temperature 29 deg. Fah. and the cooling water temperature 34 deg. Fah., but the engine started at once without priming the fuel valve connections, and it was firing regularly, we are informed, in less than a complete revolution. The manœuvring tests were extended at the request of the engineers of the Shipping Board from one to four hours. During this time official reversing and air consumption tests were carried out. The time of reversal from the moment the starting lever was thrown over, while the engine was on full speed operation in one direction, until combustion occurred in the reverse direction, averaged during the official test 8·5 seconds, with a minimum time of 4·8 seconds, whilst later the engine was reversed with ease both by the inspectors and various visitors present at the trials. In the course of twenty-four reversals with an air receiver capacity of 855 cubic feet the pressure fell from 350 lb. to 200 lb. per square inch, only about half the air being taken for reversal compared with that guaranteed by the makers. It was also shown that the engine would reverse at pressures as low as 85 lb. per square inch.

We are informed that the performance of the engine throughout the trials was highly satisfactory and the running was without incident. The following is a summary of the results obtained during the thirty days' full-power non-stop and the overload and overspeed trials:—Full-power trials: Brake horse-power, 2907; indicated horse-power, 4035; mean speed, 96·4 revolutions per minute; mean indicated pressure, 88·5 lb.; mechanical efficiency, 72·7 per cent.; thermal efficiency, 29·6 per cent.; fuel used per brake horse-power hour, 0·462 lb.; fuel used per indicated horse-power hour, 0·332 lb.; lubricating oil used per twenty-four hours, crank case (corrected for leakages), 7·07 gallons; oil for all other purposes, 7·93 gallons; total lubricating oil, 15 gallons per twenty-four hours. Overload and overspeed trials: Brake horse-power, 3409; indicated horse-power, 4639; mean indicated pressure, 99·2; mean speed, 98·8 revolutions per minute; mechanical efficiency, 73·4 per cent. The average fuel consumption over the total test period, including the thirty days' non-stop full-load run and the overload and overspeed tests, was 0·465 lb. per brake horse-power hour. With regard to these results it may be explained that the load on the engine was absorbed by a General Electric 25-cycle three-phase generator which was built twenty years ago and was originally rated at 1400 kilowatts. The efficiency of this generator was determined by an A.I.E.E. core loss code test which was conducted by the makers and the efficiency was 95·1 per cent. exclusive of excitation. Comparing the test results above given with those of the single-cylinder unit which was tested with a water brake, the engine builders are inclined to think that, with the generator highly overloaded and taking into consideration that it was rewound for a lower voltage, the efficiency of 95·1 per cent. is too high. They intend to undertake an input and output test in order to check this figure. If the efficiency is found to be too high a modification in the trial results as above given may have to be made.

It is of interest to note that the fuel oil used during the trials was a fair grade of bunker oil distinctly inferior to the ordinary Diesel oil. It had a higher calorific value of 18,733 B.Th.U. per pound with a lower value of 17,680 B Th.U. Its specific gravity was 19 deg. Baumé at 60 deg. Fah., although batches of the fuel of a specific gravity as low as 14 deg. Baumé were used. The flash point was 177 deg. Fah. and the burning point 270 deg. Fah., with a viscosity of 181 Saybolt at 122 deg. Fah. The percentage composition of the fuel was as follows:—Hydrogen, 13·02; oxygen, 0·37; carbon, 85·29; water, 0·11; asphalt, 5·95; sulphur, 0·37; and ash, 0·08 per cent.

After the trials had been run the engine was opened up and the liners were found to be in good condition, highly polished and covered with a continuous oil film. The wear over a total of sixty-seven days' running averaged two thousandths of an inch. The piston rings were well oiled and quite free, whilst measurement of the piston-rod at the region of the gland showed that the wear at that part was only in the neighbourhood of one thousandth of an inch. No carbonisation at the fuel valves was found, a result which was consistent with the clear exhaust which was maintained during the trials. From the reports with which we have been furnished it would seem as though the official trials carried out by the engineers of the United States Shipping Board have fully substantiated the makers' claims for this new design of double-acting engine. The trials will be of interest to British engineers because the engine referred to is to be built for land purposes at the Newark works of the Worthington-Simpson Company, Ltd., London, which firm intends to grant licences for marine construction in Great Britain.

BOOKS OF REFERENCE

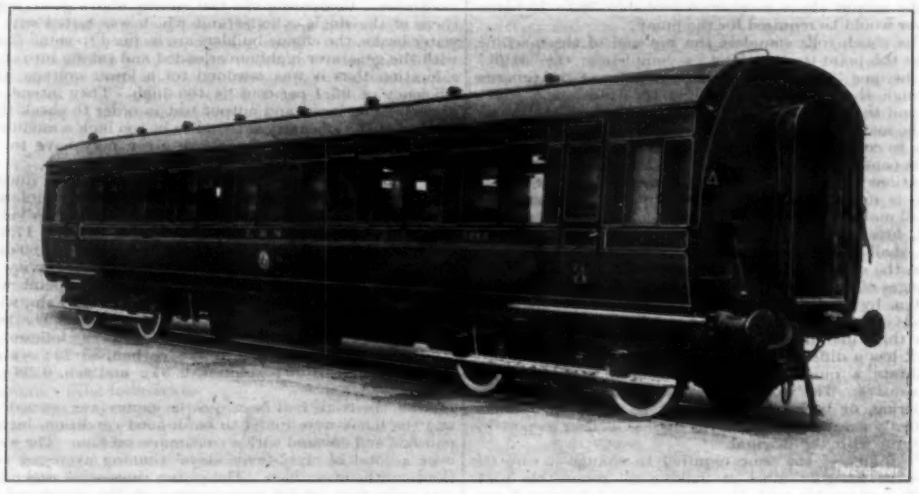
Kempe's Engineer's Year-book. Thirty-third edition. London: Crosby Lockwood and Son. 1926. 30s. net.—It is difficult to say what one would do without "Kempe" nowadays. Year by year, for the past thirty or so, it has become more and more essential to the engineer, until now it is fairly incorporated in his system. He would as soon be without his Molesworth and his slide-rule as without his Kempe. Yet we tremble when we look at its increasing bulk; this year there are more pages than last year. It was so the year before last, and it will be the same in every year to come, till Kempe grows into a cyclopedia, or all engineering is reduced to a single formula, and all the products of engineering are standardised into a few types. But for the desk, or for the shelf where the hand can reach it easily, there is no more useful book.

A NEW issue of "Reid's Handy Colliery Guide and Directory for the Counties of Northumberland, Durham, Yorkshire, Cumberland and Westmorland," has just been published by Andrew Reid and Co., Ltd., of Newcastle-on-Tyne, price 3s. 6d.—The new issue contains lists of colliery owners, collieries, agents, managers and engineers in the counties with which it deals, and other lists, including one of Associations and Institutions connected with the coal trade of the district, and another of permitted explosives. The texts of various Acts dealing with the coal trade are also included. Details of coal production, and shipped, as also of output and numbers employed, are also given. The book aims at giving in concise form such information as will be of service to those whose time is too limited to allow of their referring to the various authorities on the subjects concerning which they require particulars. This aim it appears to achieve admirably.

THE "Colliery Year Book and Coal Trades Directory" for 1926—which has just been published by the Louis Cassier Company, Ltd., 22, Henrietta-street, Covent Garden, London, W.C. 2, price £1 1s.—is now in its fourth year of publication, and it has earned for itself, since it was first published, a prominent position among books of reference. The present issue contains a complete list of all the colliery owners of Great Britain, and shows the numbers of men employed at each colliery, as well as giving other particulars, such as the constitution of the companies, their boards of directors, &c. It is interesting, in this connection, to notice that while, on the one hand, some companies employ as many as 10,000 men, there are small proprietors who employ as few as two men. Over a hundred pages of the book are devoted to statistics covering every phase of coal production and distribution, and the much debated question as to why there is such a difference between the pit head prices of coal and the prices when supplied to the householder is dealt with in a table which gives an analysis of the costs of distribution in London and in the provinces. According to this table, while the profit per ton in London is 7·5d., which represents a percentage yield of 1·38, the profit in, say, Leicester is 1s. 4·83d., which represents a percentage yield of 4·53. The year book also contains a "Who's Who" in the industry, and may be considered to have justified its claim to be a veritable encyclopædia of colliery mining.

L.M.S. RAILWAY ALL-STEEL PASSENGER COACH

CAMMELL LAIRD AND CO., LTD., NOTTINGHAM, ENGINEERS



All-Steel Passenger Rolling Stock.

For such long-distance excursion trains as those that will bring visitors from Lancashire, Yorkshire, and other centres to London to-morrow to see the Football Association Cup Tie at Wembley the London, Midland and Scottish Railway Company has introduced a new type of coach. It is of the open compartment design, which seats fifty-six passengers—forty in the brake compartment coaches—has a central gangway and has a table for every four passengers. A lavatory compartment and a luggage rack are provided at each end. The vehicles are entered by doors also at the ends and not by side doors. The trains are wholly third class and consist of six coaches and two brake thirds. A kitchen car can be added in the centre of the train should the serving of meals be part of the journey's programme. In that event any and all of the cars can readily be converted into restaurant cars.

The outstanding feature of these new trains, one of which made a trial run from Euston to Birmingham and back on Thursday, April 15th, is that the vehicles are wholly of steel. Between each end of the underframe is a box girder, consisting of a rolled steel channel headstock and crossbar, connected together by web plates top and bottom, securely riveted and strengthened by angle-shaped longitudinal members taking the compression stresses. The sole members are so designed that they form adequate struts for taking the buffing stresses. Pressed channel pillars are firmly riveted to the underframe and to the roof members and to them are attached the body side plates, which are of No. 14 gauge. The rivets are either countersunk or have snap heads. The superstructure is carried by two standard four-wheel bogies. The coaches are 57ft. in length over the body, 9ft. in width over the body, and 9ft. 3in. over the handles, the extreme height in the centre is 12ft. 7¼in., the wheel base of the bogies is 9ft., and the distance between bogie centres 40ft. 6in.

The interior of a vehicle before final completion is seen in one of the accompanying illustrations. Some of them have the side and end panels lined with insulating material and the roof sheets lined on the outside with canvas. That has been done in order to prevent drumming when in motion and to guard against radiation of heat or "cold" from the steel sheets. In other coaches the same end has been achieved by providing a free air space right round the car between the inner and outer linings. The interior finish in the majority of the coaches is of polished mahogany, practically identical with that of the standard stock of the railway company. In other cars the finish is of steel with special decorative schemes.

The ventilation is effected by means of torpedo extractors in the roof and glass louvre ventilators on the sides. The latter may be altered and regulated, either for extracting or intake, as desired. Alternate windows are arranged for a full opening. The cars are heated by steam radiators, on the Westinghouse atmospheric pressure system, along both sides and under the control of passengers by means of levers connected to Bowden wires. The floors are of Decolite, laid on suitable steel plates and covered with felt and linoleum. The electric lighting is, in some cases, by Stone's double battery system and in others by the Vickers single battery method. All the lights are under the control of the guard and those over the tables may be switched in or out by the passengers.

INTERIOR OF ALL-STEEL COACH, METROPOLITAN CARRIAGE, WAGON AND FINANCE COMPANY

The number of coaches of the type described is 235, of which thirty-five have brake compartments. The order was divided between the Birmingham Carriage and Wagon Company, Cammell Laird and Co., the Leeds Forge Company, and the Metropolitan Carriage, Wagon and Finance Company. The firms named were allowed to make variations in details of construction, in order to furnish some practical experience, under the conditions operating in this country, of the methods employed by those manufacturers in the construction of all-steel vehicles for use on foreign railways. In general, the design of the cars is the work of Mr. R. W. Reid, the carriage and wagon superintendent of the London, Midland and Scottish Railway.

THE tender of Sir Wm. Arrol and Co. for a new bridge over the Wear at Sunderland has been submitted to the local Council for acceptance. The scheme will involve an expenditure of at least £200,000.

South African Engineering Notes.

Platinum Activities.

THE production of the first platinoid sponge turned out upon a commercial scale in South Africa has greatly encouraged those responsible for the administration of the mines with proved tonnages of payable ore and their technical advisers to go ahead with ambitious programmes of development and equipment. On Onverwacht mine, the first platinum producer, a new vertical shaft is being sunk and much additional plant is being put in. The Potgietersrust Platinum Mines are embarking on an extensive programme, both above and below surface. Large quantities of machinery are going forward for the Northern Platinum Exploration Company. At the Transvaal Estates and Development a pilot plant is to be erected and development work is proceeding on a large scale. At Maandagshoek and Divors River of the Lydenburg Platinum Areas pilot plants are being rushed up, and in the Waterberg district the Transvaal Platinum Company's plant has been completed. At various other properties, too, constructional and development work is being pushed on. It is stated on good authority that one important concern has in prospect an outlay running to seven figures upon development, and that it is proposed to speed up development work and the erection of plant, so that production upon a basis of 60,000 tons may be reached as soon as possible. This by no means represents the total either of outlay or tonnage in the near future, and on the schemes which one knows of, it is estimated that it is highly probable that an amount of 5 millions sterling will be expended upon machinery and equipment during the next three years. In January 471 Europeans and 6558 natives were at work on platinum mines, compared with 459 Europeans and 5697 natives, which will give an idea of how the industry is growing.

The platinum concerns of the Transvaal have already paid away very large sums of money on equipment and mining supplies, and their expenditure accounts will show great expansion during the next few months. As a guide to manufacturers of mining and metallurgical machinery, a few items of purchases to date may be enumerated. The following does not pretend to be anything more than an indication of the needs of the platinum industry up to this stage, but it will also serve to show the variety and volume of the market that exists for machinery manufacturers who are keeping an observant eye on the development of the new industry. Portable compressors, jack hammers and winches, gas engines, small electrical sets, switch gear, aerial ropeways, gravity stamps, tube mills, ball mills, Wilfley concentrators, Lining head gears of light type, sinking buckets, rope windlasses, building material of all kinds (galvanised iron, cement, timber), small light trucks, generators, sinking pumps, diamond drills, explosives, steel boxes for holding concentrates, shafting, driving belts, boilers, steam engines, drill steel, carbide and lamps, assay furnaces, chemicals and assayers' requisites, theodolites and survey appliances, tram lines and trucks, grizzley bars, ore feeders, disc crushers, &c. &c. The market is an expanding one, and merits the close investigation of manufacturers.

An Eight-hours Day.

The Minister of Railways and Harbours of the Union of South Africa has announced the Government's intention to grant an eight-hours day to the running staff and concessions to some other grades which will involve an additional expenditure of £250,000. To have granted the eight-hours day all round, as the employees wished, would have cost about £800,000 a year additional, and that the Government could not entertain, hence the compromise.

Mineral Output for 1925.

The value of the total production of minerals in the Union of South Africa during the year 1925 was £54,251,976. The 1924 total was £57,786,224, but it included the premium on gold, amounting to £3,813,739. The following are the figures for 1925 and the comparable figures for 1924 :—

	1925. £	1924. £
Gold	40,767,982	44,500,365 (with premium)
Gold	—	40,672,447 (at standard)
Silver	166,842	212,602
Osmiridium	170,995	102,886
Diamonds	8,198,368	8,029,466
Coal	3,880,442	3,830,163
Copper	495,797	511,844
Tin	298,973	304,108
Other minerals	272,577	294,790

The total quantity of gold-bearing ore mined in 1925 was 28,682,238 tons, compared with 28,581,930 tons in 1924. The gold produced was 9,599,702 fine ounces, compared with 9,597,634 fine ounces.

Witbank Power Station.

Rapid progress is being made with the construction of the electricity generating super-power station at Witbank (Transvaal), which belongs to the Electricity Supply Commission. Every effort is being made to complete one of the three 20,000-kilowatt sets, and it is hoped to have the first machine under load in a few weeks' time. In view of the recent accident to one of the sets at the Vereeniging Station, every expedient is being resorted to that will hasten the completion of one set at Witbank, so as to leave an ample margin of supply available over the whole Witbank-Rand system.

Petroleum in S.W. Africa.

For some years prospectors and geologists have been reporting oil seepages as occurring in certain areas of South-West Africa, formerly German South-West Africa, but now mandated by the Union Government. In consequence, the Petroleum Corporation of South-West Africa was formed, and Dr. L. Reinecke, a distinguished petroleum geologist, who has held responsible positions with the Sinclair Oil Corporation of New York and the

Geological Survey of British Columbia; Dr. Hans Merensky, consulting and mining engineer, late of the Mines Department, Prussia, whose name has been closely connected with the platinum discoveries in the Transvaal, one of the principal platinum-bearing reefs being styled after him, the "Merensky Reef"; and Mr. Helge Heiberg, an engineer, were asked for independent reports, which they did, in all cases favourably.

Dr. L. Reinecke was next commissioned to select suitable sites for boring and he recently returned, having finally determined the site of the first bore-hole, which is 48 miles north-west of Gibeon. The Corporation has since entered into a contract with the Chapman Drilling Company, of Johannesburg, which is to sink a bore-hole at the site selected by Dr. Reinecke to a depth of approximately 3000ft., following which a further programme of boring is contemplated, when it is hoped to determine conclusively the oil-bearing qualities of the areas at present possessed by the Corporation. Boring was commenced on March 1st.

Rhodesian Chrome for U.S.A.

The Vanadium Corporation of America has exercised its option to purchase the chrome properties of the African Chromite Corporation for a large sum of money, approaching, it is said, six figures. The ground embraces 172 blocks, and extends from Banket to Darwendale. For the past twelve months it has been subjected to tests. The company intends to operate on a large scale, exporting the ore to America for its own industrial purposes.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Trade Situation.

LAST week's quarterly meeting of the Midland iron trade has had no appreciably beneficial effect upon the iron and steel trades of this district, and market conditions to-day were as dull as before the meeting took place. The new business placed was very meagre, but having regard to the unsettled industrial situation, it is not surprising that buyers continue their non-committal attitude. Contractors find it impossible to make plans for the future, while the coal issue remains unsettled; and it follows that in most departments purchases are being made on the hand-to-mouth principle. Producers also are disinclined to contract forward, and little improvement is to be looked for "until the clouds have rolled away." All interest is therefore centred in the efforts being made to secure amicable settlements between employers and employees in the coal and engineering trades.

Staffordshire Bar Iron.

The Staffordshire bar iron industry remains indolent. Some of the mills have sufficient business on their books to ensure activity till the end of the month, but there is no quickening of demand in any direction. Even the marked bar mills are none too well occupied, though many of them are getting a share of the business given out by the constructional engineers engaged on factory extensions and building reconstruction schemes. The basis rate of £14 for marked bars is maintained. The position of unmarked bars has become more confused. Lancashire houses have notified a revision of prices in their own district, making Crown bars £11, and nut and bolt and fencing qualities £9 15s. Staffordshire ironmasters, however, have not changed their quotations. They take up the position that on the irregular orders they are getting, the old prices are barely economic, and there is no reason to suppose that any possible concession would materially enlarge the turnover. Moreover, any minor change one way or the other with regard to nut and bolt iron would be of little account, in view of the substantially lower prices of similar iron from Belgium. Staffordshire unmarked bars of Crown quality, therefore, continue quoted £11 2s. 6d. upwards, and nut and bolt at £10 5s. No. 3 Belgian iron is offered at £5 8s., f.o.b. Antwerp, equal to £6 10s. delivered, a reduction of about 2s. 6d. It is hardly surprising therefore that the bulk of the material used in the Darlaston and district nut and bolt works is imported. The tube makers are only moderately busy, and £12 10s. is still asked for iron strip.

Pig Iron.

The demand for pig iron remains meagre, and furnaces are experiencing some difficulty in disposing of their output. Strenuous efforts are being made to uphold recent selling prices. Some of the principal Derbyshire makers, who are prepared to hold the uncommitted margin of their output rather than entertain any shading of the £3 7s. 6d. figure for No. 3 foundry iron, are securing very little support. They are unable to prevent competitors for the business accepting lower rates. Many sellers recognise that the position is no longer so strong as it was during the buying movement which marked the earlier part of the year, and they intimate their willingness to shade prices to a varying extent, according to the size of orders and individual circumstances. Buyers concede the £6 7s. 6d. figure only in very special circumstances for small accommodation lots; hence the market rate is determined by transactions which carry a concession to the buyer. In any case, the volume of business, whether as regards Derbyshire No. 3 or any other description of pig iron, is very limited. Buying is almost entirely for small lots, for with the coal uncertainty, neither buyers nor sellers are inclined for large bookings. The pig iron production for March was 568,500 tons, an increase of 66,000 on the month, and the best figure since May of last year. Some of the business done is undoubtedly precautionary, by founders and others, in view of strike possibilities. Blast-furnace coke is in plentiful supply, and values are weak.

Steel Values.

The principal movement in the steel department is the raising of the price of structural material. Engineers who placed contracts at last week's quarterly meeting acted wisely, for hardly had the meeting terminated than it became known that the reconstituted Steel Manufacturers' Association has wasted no time in applying its control to the raising of prices. Only three weeks previously it fixed the basis price for the Midlands at £7 for angles and joists and £7 15s. for structural plates, figures which were then considered by the local makers, as stated in my letter at the time, to be too low. It has now advanced the minimum for angles and joists in this area half a crown per ton, making the new selling figure £7 2s. 6d., and ship, bridge and tank plates by a similar amount, bringing them to £7 17s. 6d. It is emphasised that these are not flat rates of general application. There will be variations according to the carriage payable, size of order, and other relevant circumstances. In some circles doubts are expressed as to the wisdom of advances at this juncture, although it is admitted that the policy may have a certain sentimental value. In other departments of the steel trade, prices are much as a week ago. Small rolled bars are based on £7 15s. It is reported that business has been done in continental bars at rather less than £6 2s. 3d. Outside competition is keen in strip. The Staffordshire basis remains at £10 10s. Soft billets are £6 2s. 6d., but sheet bars can be bought down to £6. Foreign competition does not relax; indeed, it is considered to be rather keener. Foreign billets can be bought here at £5 5s., representing a small reduction, while sheet bars are quoted £5 10s. Germany is competing more vigorously in this market, and has sold some heavy lots of strip to leading tube makers in this district. Germany also continues an active seller of cold rolled steel for the requirements of the motor, cycle, and other industries, quoting a figure about £3 per ton below local makers' prices. Throughout all departments of the steel trade orders are for small quantities for immediate requirements, but the comparatively small tonnages placed are sufficient to keep works fairly well engaged. There is still a good deal of idle plant, but this is partly attributable to the general speeding-up which has been in progress, especially during the past twelve months. It is well known that the railways, who have been the principal buyers for some time, have still large orders to give out, and prospective rolling stock business for colliery requirements is also large. Some important building contracts have been given out, and others are waiting the coal settlement, so that steelmasters are not discouraged.

Galvanised Sheets.

The situation in the galvanised sheet department remains much as it was a week ago. Business is fairly good, both on home and export account. Quotations continue to show unusual disparity. While many makers ask £16 to £16 5s. for 24 gauge, corrugateds, others offer supplies at £15 15s., and for large-scale export orders £15 10s. per ton f.o.b. is stated to have been accepted. Few mills, however, would entertain business at this figure.

The All-Steel Train.

Considerable interest was manifested last week in the Midlands in the all-steel train run by the London, Midland and Scottish Railway Company from London to Birmingham, with a view to showing what is being done on British railways with regard to all-steel passenger rolling stock. Comment appears generally to have been favourable. Industrialists here foresee in the event of the general adoption of this class of coach, an additional outlet for their production of steel. In these days manufacturers welcome anything which results in the greater use of British products, and, further, they hold with Mr. W. L. Hichens, a director of the London, Midland and Scottish Company, that such coaches should be more durable than the wooden ones, and more in accordance with "safety first" principles in the event of railway disasters. At a luncheon given to representatives of colonial Governments and railways and members of the Press, Mr. R. W. Reid, carriage and wagon superintendent of the company, stated that the cost of the steel coach was a little more than that of the wooden one, and there was little difference in weight. It is held by railway stock builders hereabouts that the small additional cost would be more than compensated for by the longer life which such coaches will have. Those who travelled on the train afterwards visited the works of the Birmingham Railway Carriage and Wagon Company, Smethwick, and the Metropolitan Carriage, Wagon and Finance Company, Saltley, where further all-steel coaches are being built, and all were extremely interested in the various stages of manufacture.

Edge Tool Trade.

The heavy edge tool trade of the Midlands has slackened considerably in the last week or two. The spring boom lasted longer than might have been expected, and, having spent its main force, it settled down to a steady demand which lasted up to the approach of the Easter holidays, but since then business seems to have dropped away rather suddenly. This is particularly the case in regard to Eastern markets. It is not unusual for these markets to become quiet at about this time of the year, but there have been several other factors, some of them political, which may have entered into the situation this year. The South American markets are recovering, though slowly. Inquiries from this source, however, are encouraging and hold out prospects of increased business.

The New Power Station.

The giant super-power station, which is being erected at Stourport, on the river Severn, to supply electricity to hundreds of market towns and villages in the Midlands, is expected to be ready for use next month, and it is hoped that the opening ceremony will be performed by the Prime Minister, Mr. Stanley Baldwin. The new station, which is one of the largest of its kind in the country, will have a capacity of approximately 200,000 horsepower, and will generate enough electricity to meet all the demands that are likely to arise for years ahead.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

General Outlook.

IN the iron and steel markets here there has been a rather more hopeful feeling as to the outcome of the negotiations in the coal industry, although it is not by any means reflected in the state of the markets themselves so far as the weight of business is concerned. The outlook is, of course, primarily a matter of individual psychology, and while some people take a grave view of things, and others are inclined to sit tight and wait developments, there are plenty who express the view that a way out will be found and that a stoppage of the coal-mining industry—which neither employers nor employed are anxious to see—will be avoided. The net result of this conflict of opinion, however, as has been indicated, is by no means in favour of an expansion of trade. A more serious view seems to be taken of the position in the engineering industry, and this is probably a factor which is having the greater influence on business. Whilst, however, the London situation has reached a critical stage, the position in Manchester and the surrounding districts is nominally unchanged from what it was when I last wrote, namely, that the local application for increased wages will go to the Central Conference at York on May 14th.

Non-ferrous Metals.

The erratic movements of the non-ferrous metals, which have been so marked a feature of this market for some weeks, have continued. Stronger advices from the United States as to the statistical position stimulated values in the copper section, and with a slight improvement in the demand from the Continent, values finished up rather better than they began the week, but the reaction which set in in the early days of the present week brings us to pretty much where we were. Very similar conditions affected the market for tin. Urgent American demands sent the price up to a substantial extent, and the week closed, after some easiness, on a much firmer note than it began. There has since been a further relapse which leaves the position on balance more or less what it was as last reported. Spelter is still probably much the firmest section, and although there have been ups and downs in common with the other metals, values have not shown much important change. Lead is also fairly steady, and an improvement in buying at one period of the week had its effect on quotations, and although some reaction took place, the tone is fairly steady at the moment of writing. The demand for all classes of non-ferrous metals locally continues, however, on a comparatively restricted scale.

Iron.

Users of pig iron were influenced by the fear of a mining stoppage at one period during the past week to the extent of placing an increased number of orders for small quantities with a view to eking out stocks and existing contracts, and whilst this feature persists to some extent, it is less prominent than it was. Several makers of pig iron report that those consumers who are fairly busy just now and whose contract orders are becoming exhausted, are showing no hesitation in renewing these on a smaller scale. On this market there are no important changes in prices to record, and up to now sellers are showing no anxiety to reduce them. Lincolnshire and Staffordshire No. 3 foundry pig are both quoted at about 76s. per ton, with Derbyshire at 75s. to 75s. 6d., Scotch iron at 94s., and West Coast hematite at 93s. to 94s. per ton, all for delivery in Manchester or equal distance. East Coast hematite is quoted here at about 76s. per ton, on rails, at furnaces. There is only a small trade passing in forge iron, which is being offered at about 72s. 6d. to 73s. per ton for Derbyshire and Lincolnshire makes. Crown bars continue quiet at the reduced price of £11 per ton, with second quality bars at £9 15s., delivered in the Lancashire area.

Steel.

Firmness characterises quotations in the steel market, and joists and sections are well held at £7 2s. 6d. per ton, ship-plates at £7 17s. 6d., boiler-plates at about £11, and steel bars at £8 to £8 5s. per ton, delivered Manchester or equal distance. At £8 sales of several fair-sized parcels of bars have been made during the week, although one still hears of £7 17s. 6d. being mentioned. Apart from an odd contract for constructional steel being placed there has been little important business transacted. Most of the current demand continues to be for rather small lots, although the higher prices for which steel makers are now holding are said to have created a better tone in the market. The expected seasonal improvement in the demand from India for galvanised sheets has not yet set in, and it is stated that the recent troubles in Calcutta have not been without their influence in this respect. Earlier in the week quotations for sheets still displayed a markedly weak tendency, but latterly there has been a firmer feeling. About £15 2s. 6d. was the figure at which at one time actual business was being done, and at this price several hundred tons for India were disposed of, but there has since been a firmer tone, and £15 5s. to £15 10s. per ton f.o.b. for Bombay or Calcutta specifications is about the present range of prices. Continental competition in the trade in black sheets is a prominent feature of the market, and not much business has been done here. For continental materials inquiry is slow and actual business is quiet. Prices are easy at about £5 15s. per ton for joists, delivered Manchester for net cash against shipping documents, £6 5s. for Belgian iron, £6 7s. 6d. for ordinary plates, £6 12s. 6d. for Siemens' plates, £6 for steel bars, and £5 4s. for sheet bars.

Scrap.

There is still only a limited demand being met with for both iron and steel and non-ferrous metal scrap. Mild steel is very weak at about 52s. 6d. per ton, ordinary machinery cast iron scrap at 65s., textile machinery scrap at about 70s., and wrought iron at 65s., free on truck in Manchester. For sorted and graded qualities, delivered to consumers' works, aluminium scrap is at £88 to £90, best selected gun-metal at £52, zinc at about £24, lead at £29, heavy copper scrap at £59, and brass rod turnings at about £40 per ton.

Paper-making Machinery at "The Mechanicals."

There was a very gratifying attendance at the meeting of the Institution of Mechanical Engineers—North-Western Branch—held on Thursday, 15th inst., at the Engineers' Club, Manchester, to hear and discuss Messrs. Beaumont and Burt's paper on "The Modern Development of Paper Mill Plant." In Mr. Beaumont's absence the paper was read in abstract by his collaborator, and an animated discussion followed, the principal speakers being paper makers who had been invited to attend. This proved to be a very wise procedure, as the speakers were able to make very welcome contributions on the subject, and corrected the authors on several points. On the other hand, the contributions to the engineering side of the discussion were negligible. One of the chief points of contention was with regard to the "wires." Their construction, operation and life all came in for criticism, and there seemed to be some difference of opinion amongst the practical paper makers themselves as to what really happened when the "stuff" is fed on to the wire. In fact, it would appear to an outsider that the craft of the paper manufacturer is based more on custom and experience than upon scientific knowledge. To deal at all adequately with such a wide-reaching subject in the course of a couple of hours or so was obviously quite impossible, and many more speakers were available had time permitted, but all were agreed that this paper is one which will enrich the "Proceedings" of the Institution and will prove a valuable source of reference.

Barrow-in-Furness.

Hematite.

The hematite pig iron trade in the North-West District continues to be quiet, and there is a dearth of heavy orders with deliveries to be spread over a period. Many customers who placed orders of that description some time ago are not keen on repeating them at the present time, and until there is more confidence in the industrial world as regards labour, trade will continue to be quiet. But for the fact that the steel departments at Barrow and Workington are taking a fair quantity of iron, there would have to be a curtailment of the output of iron, for it is not policy to accumulate stocks. The Midlands are taking the biggest deliveries and Scotch business, on the whole, is poor. The business with continental buyers is very small, but trade with America continues, and a cargo of 5000 tons has just left Barrow, the iron coming from Barrow, Millom and Ulverston. This iron, as a rule, is of a semi-special quality.

Iron Ore.

The iron ore trade is, generally speaking, quiet, having to rely to a great extent upon the local demand, as little is being sent out of the district. The coastwise trade is also small. Foreign ore is coming in in restricted quantities, and is likely to do so until there is an improvement in the iron trade generally.

Steel.

The rail mills at Barrow are working again, and contracts are held which will keep them going for a limited period, but fresh orders are necessary to assure anything like a long run. At Workington the rail mills hold certain orders, but there are not sufficient to keep them going regularly. The foundry and Siemens' departments are moderately employed.

Shipbuilding.

The Furness, Withy steamer, Nova Scotia, is practically completed, and will soon be ready for her station. Work is proceeding with the new Orient liner, which will be similar to the Orama and the Otranto, which were built here. The keel is laid. It will not be long before the first of the two Australian submarines will be launched, and the other will leave the stocks in due course. The cruiser Cumberland is being fitted out in the Buccleuch Dock.

SHEFFIELD.

(From our own Correspondent.)

Steel Buying Suspended.

Anxiety as to the outcome of the trouble in the coal world is having a retarding influence on the steel trade, which is particularly unfortunate at this time, when production was showing a steady tendency to advance. Manufacturers have quite enough difficulties with which to contend in these days without additional troubles coming their way. The market is extremely sensitive, and the clouds hanging over the coal and engineering trades, are reflected in the tailing off of inquiries in all branches of the Sheffield steel industries. Although there is a general feeling that serious trouble will be avoided, everybody is taking precautions in the event of the worst happening. A certain risk, which they cannot very well avoid, is being taken by the open-hearth steel furnaces, and at the moment, though the chance of disposing of their output is less than it was, they are maintaining the rate of working, which has been justified during the past few months. The general position of the steel industry, disregarding the present exceptional circumstances, is favourable, and gives hope for encouragement, if only labour troubles can be got out of the way. The output of steel in this country for last month was 80,000 tons more than it was in February, and was 100,000 tons more than the production for March of last year. Last month's export returns, too, were of an encouraging character. It is interesting to note that during the quarter ending March 31st, Sheffield supplied steel to the value of £83,000 to the United States. Practically no trade can be done with the Continent at present in the better grade steels, largely owing to the adverse influence of the foreign exchanges. The scrap market is featureless, and with both merchants and users holding out on the question of price, the only business passing is for small lots.

Engineering Departments.

There is a general complaint of declining business in the finished and semi-finished departments. Quieter conditions rule in the rolling mills and forges, and the heavy engineering shops are having a difficult task in trying to make up in other directions for the shortage of work from armament and shipbuilding sources. Railway work is attracting most interest, and though a lot more orders could be accommodated, the position of this branch is fairly satisfactory. The Bengal-Nagpur Railway Company is inquiring in Sheffield for buffer cases and parts, and other work for the Indian railways has recently been tendered for. Sheffield firms have cut their quotations to a low point to secure Indian railway contracts, but German and Belgian competition is a serious proposition. Sheffield shares, directly or indirectly, in several contracts that have been received recently from overseas railways. Cammell Laird and Co. and the Metropolitan Carriage, Wagon and Finance Company, which is a subsidiary concern of Vickers, have each received orders for one hundred high-sided bogie wagons for the Rhodesian Railways, and Craven's Railway Carriage and Wagon Company, of Darnall, Sheffield, is to supply twenty-five bogie goods guards' vans.

Another Railway Development.

Doncaster rail plant workers received an item of good news last week when the announcement was made that, with the exception of the men employed in the Crimpsall repair shops, they would revert to full time work. This decision affects between 2000 and 3000 men, who have been working short time for about a year, in the carriage department, boiler, machine and smiths' shops, and the foundries.

Engine Coaling Plant.

Doncaster's growing importance as a railway centre, which has involved extra coaling since the grouping system came into operation, has necessitated the erection of a new coaling plant. This will be completed in a few weeks, and will be the most up to date of its kind in Yorkshire. About 250 engines use Doncaster as their headquarters for coaling purposes, and the new plant will enormously facilitate the operation. It consists of a large hoist, 100ft. high, built of reinforced concrete, and it will accommodate 500 tons of coal in its overhead bunkers. The coal is put into the bunkers by means of an electric hoist, capable of raising with ease a 20-ton wagon. When nearly at the top of the structure the contents of the wagon are tipped into the bunkers, and the coal is fed into the engine tenders below through smaller shoots. Two engines can be coaled at the same time, and the rate of feed is 5 tons in two minutes, thus enabling one of the monster "Pacific" engines, which carries 8 tons of coal in its tender, to have its supply replenished in less than five minutes. An apparatus for sanding is attached to the new plant.

Plate, Cutlery and Tool Trades.

Orders for plate and cutlery continue to fall away, and these branches are now in a most depressed state. An additionally alarming feature is the manner in which colonial orders are declining, and the amount of material now being prepared for export is considerably smaller than it should be for this period of the year. The bulk of the business received is from catering establishments. Public sales are poor and variable, and travellers for Sheffield houses are having a lean time. Most of the demand is for the cheaper quality goods. Stainless knives are still being produced in large numbers, but compared with recent outputs the trade can almost be said to be experiencing a slump. It is only very special orders that the big houses are receiving for silverware and the best quality electro-plate. The tool trades, which have been depressed for some time, record no improvement, and the decline in orders is difficult to account for. Russian buying, which was of great help to Sheffield last year, is now only being met with in small casual lots, but that alone does not account for the slump in trade. Other buyers who were prominent in the market last year are also lying low for the present.

New Gasworks Plant.

Dewsbury Corporation gasworks have been enlarged and modernised at a cost of £33,000, and the new works were formally opened this week. The old retort house, which contained five beds of seven hand-charged retorts, has been demolished, the new plant being erected on the same site. There is a new steel and brick retort house, with a horizontal retort installation, consisting of seven beds of ten retorts, each 23ft. long. A mechanical stoking machine, a coke machine and quenching bench, coal-conveying, breaking, elevating and storage plant, and gas-driven electrical generators of 60 kilowatts capacity, have also been installed. The works also possess plant for the de-hydrating of tar. The Dewsbury gas engineer and manager, Mr. H. L. Bateman, prepared the specifications and plans for the new works and plant, and the work has been carried out by Gibbons Brothers, of Dibdale Works, Dudley. The combined retort charging and discharging machine is of the projector type, supplied and erected by Ride and Bell, of Misterton. It is electrically driven throughout, and has separate motors for charging, travelling and hoisting. The coke-handling plant, supplied by the same firm, takes the coke from any of the five tiers of retorts and deposits it through openings in the retort house wall on to a quenching bench alongside.

Lead Mining News.

Mr. M. H. Herd, of Fleetwood, the owner of 3 miles of lead mines in the Matlock Valley, has informed the Matlock Council that he proposes to make an examination of several shafts of the mines in the vicinity of High Tor. He has also intimated that his scheme is a preliminary to a large undertaking. An item of news of an opposite character is the announcement that the Brough Lead Works Company, owing to lack of trade in the lead industry, has closed down its works at Brough, Bradwell, Derbyshire, which have been in operation for over seventy years.

NORTH OF ENGLAND.

(From our own Correspondent.)

The Trade Position.

Although business generally in the iron, stee and coal trades in the North of England is still largely in a state of suspension, pending the outcome of the negotiations on the coal crisis, a distinctly more hopeful view is now taken of the situation. The prospects of a settlement are believed to be bright, and if a settlement is effected it is confidently anticipated that a considerable volume of business, which has latterly been held up, will be released. In the pig iron trade many contracts are now expiring and makers would no doubt welcome a renewal of buying, especially as business with the Continent has almost ceased; but it is futile to hope for any forward business until the industrial outlook clears.

Cleveland Iron Trade.

There are no new features of moment in the Cleveland pig iron trade. Business is almost at a standstill, the chief contributing cause being the shadow of labour unrest. A suspension of operations at the collieries would be speedily followed by the closing down of the ironworks. Continued unsatisfactory rates of exchange are also assisting materially to check business. Customers in nearly all branches are most cautious in their dealings, and the general feeling of uncertainty is responsible for manufacturers being markedly disinclined to commit themselves at all extensively. Usually at this season of the year a large volume of export trade is passing, but at present inquiries from abroad are meagre. Makers of Cleveland pig iron have next to no stocks, and have very little iron to offer for sale. Their continued strong position enables them to uphold market quotations, and they altogether disregard customers' persistent claim for price concessions. No. 1 Cleveland foundry iron is 73s., No. 3 G.M.B. 70s., No. 4 foundry 69s., and No. 4 forge 68s. 6d. per ton for home use. In the case of export orders, 6d. per ton more is asked.

Hematite Pig Iron.

The position in the East Coast hematite pig iron trade has weakened perceptibly. Makers are stated to be already selling at a loss, and see no point in cutting quotations, when the effect is merely to strengthen the determination of consumers to hold off the market. Nevertheless, stocks are increasing, and probably a firm offer of business would secure hematite at less than the quoted rates, viz., mixed numbers 76s., No. 1 quality 76s. 6d. per ton.

Ironmaking Materials.

Very few inquiries are reported in the foreign ore trade, but deliveries under running contracts continue on a heavy scale. Best Rubio ore is nominally round about 21s. 3d. per ton c.i.f. Tees. The coke trade is quiet, good medium furnace kinds being freely offered at 18s. 6d. per ton delivered at the works.

Manufactured Iron and Steel.

Notwithstanding the hesitancy on the part of buyers created by the coal crisis, it is understood that a fair number of orders for steel manufactures have been placed on the North-East Coast this week. An advance of half a crown in the home prices of steel ship plates and sections has not come as a surprise. It is the first outcome of the closer association of the steel manufacturers, and as discussions are proceeding, further developments in the direction of stiffening up prices are not altogether improbable. Steel ship plates are now £7 12s. 6d. home, £7 export; steel angles and joists, £7 2s. 6d. home, £7 export. A fall in the price of spelter has reduced the price of galvanised sheets, sales being reported as low as £15 5s. per ton, though some of the makers, well situated for business, are holding out for higher figures.

The Coal Trade.

There is no development in the Northern coal trade. Everything is dead idle, and there is scarcely an inquiry of any sort. This inactive state is likely to prevail until there is some practical outcome of the deliberations between the coalowners and the miners' leaders in London. There is certainly little prospect of more trade for this month, and until there is a clearer outlook for May, and beyond, forward business is almost out of the question. Apart from the possibility of a national stoppage at the pits, the prolongation of the negotiations is calculated to turn potential customers abroad more and more to other than British sources for their coal. At the same time, there does not appear to be any interest among foreign consumers as to the possibility of any stoppage of the coal mines in this country, for they are well stocked, and are receiving offers of coal from the United States, Germany, Holland and even Russia. There is no movement of note in the Northumberland steam coal section. A few parcels only are offered by contractors, but in view of the lack of competition for them, prices are rather easy. Best Blyth qualities are almost nominal and undisturbed at 16s. to 16s. 6d.; Tyne primes remain at 15s. 6d. to 16s.; and seconds at 15s. to 15s. 6d. The tone is steady for small steam fuel. There is but a meagre surplus of output,

if any, and prices are held steadily at 8s. 6d. for bests, with specials at 10s. 3d. to 10s. 6d., and seconds at around 8s. In the Durham section there is no altered feature. Prices are about steady on a nominal basis. Gas coals remain unchanged at 18s. 6d. to 19s. for bests; 19s. to 20s. for specials, and 15s. to 15s. 6d. for secondary sorts. The demand for coke remains lifeless. Neither prompt nor forward buyers are willing to operate, and consumers still hold for further concessions in price. Gas coke is freely offered at 18s. to 20s., but fails to attract. Patent oven cokes are weak at 17s. to 20s., and beehive descriptions are quoted from 26s. to 30s.

New Industry for Tees-side.

The new steel tube works, the only one of its kind in the North of England, which has been under construction at the South Durham Steel and Iron Company's works, Stockton, is expected to start manufacturing at the beginning of next month. The company has been successful in securing some important contracts, including the supply of several miles of 42in. steel pipes for the third instalment of the Vyrnwy water supply for the Liverpool Corporation, together with 24in., 30in. and 40in. steel water pipes for the Manchester Corporation, and also an important section of the steel piping required for the new undertaking of the Dublin Corporation waterworks. A feature of these contracts is that all the pipes will be lined by the "Talbot" patented hydro-carbon process as a protection against corrosion. The first section of the plant is capable of manufacturing steel tubes up to 72in. diameter and 30ft. in length.

SCOTLAND.

(From our own Correspondent.)

Stagnant Conditions.

IRON and steel markets on the whole are stagnant, and it is difficult to perceive any feature calculated to inspire the slightest encouragement. Markets generally are dull, and the general inquiry for steel, iron and coal leaves much to be desired. The industrial unrest is doubtless responsible to a considerable degree for the position, and a rapid improvement may follow an early settlement.

Shipbuilding.

While new shipbuilding contracts are not now so numerous as they were some weeks ago, fresh orders are still being reported, and though they may be of comparatively small tonnage, they still give cause for gratification. Two or three orders have just been placed for fruit-carrying steamers of 300ft. and 400ft. in length on behalf of Elders and Fyffes, of London. Rumour has again been busy concerning orders for large motor liners, but nothing definite has yet been announced.

Steel.

The position of the steel market continues disappointing. The production is on a low level, and outputs are not easily disposed of. Home and export demands are equally disappointing. Ship plates and sections are extremely slow. The expectation that the fixing of prices would lead to increased business has not yet been realised, whatever may eventually happen.

Prices: Extension of Control.

It has been decided by the Steelmakers' Association to advance the controlled prices of ship plates and sections for the home trade by 2s. 6d. per ton, thus making the new price for ship plates £7 12s. 6d. per ton and for sections £7 2s. 6d. per ton. It has been decided also to bring the export price of sections under control, with an established quotation of £6 5s. per ton. The advanced prices are an indication that those ruling previously were unremunerative.

Steel Sheets.

Makers of ordinary sheets are not too busy, and prices for both black and galvanised varieties are inclined to weaken. It is reported that many export orders are being withheld meantime, owing to unrest abroad. Makers of certain types of certified finish are as a rule very busy. Some producers of galvanised sheets are busy, while others are losing time and are offering easier prices.

Iron.

The bar iron market is discouraging. The general demand is weak, and some makers are offering easier prices for export. In the re-rolled steel branch of the trade a similar situation exists, and steel bars and small sections are slow to move. Crown quality bar iron for export is round about £11 per ton, and re-rolled steel bars are about £7 10s. per ton, home or export.

Pig Iron.

Business in pig iron is at a low ebb. Owing to the lack of demand, prices are nominally unchanged.

Coal.

That the uncertainty in the coal trade has reacted against business is practically without question. The speculative element has been almost entirely absent, while export consumers have been placing their orders where delivery is assured. Consequently, a considerable amount of business has undoubtedly been lost to home collieries. While there is a certain amount of optimism concerning the outcome of the negotiations at present taking place in the industry, neither owners nor buyers are inclined to commit themselves, and business meantime is almost entirely confined to immediate requirements. Demands therefore are restricted, and the collieries are in need of orders for all descriptions of fuel, not excluding those fairly well booked at present. Lanarkshire splints are comparatively well placed, but ells are now barely steady. Lothians steams are perhaps a trifle firmer, but this is probably temporary, as the turnover has not increased. Fifeshire steams are rather difficult to dispose of, owing partly to the slow development of the Baltic trade. Ayrshire collieries are fairly well placed, owing to demands from the Irish market. Small stuffs as a rule are rather badly off at the moment, and prices show a weakening tendency. Shipments amounted to 265,485 tons against 238,701 tons, and 246,211 tons in the same week last year. Home demands are slackening, and all descriptions are plentiful.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Outlook.

THE uncertainty as to what is going to happen at the end of the month is having a paralysing effect upon business in coals for May shipment. There is at the moment a rush for supplies, principally for export for loading this month, and the home demand is more active. The docks are pretty full of tonnage, as may be gauged from the fact that this week commenced with thirty steamers waiting for coal berths. Many boats are already on demurrage, and have scarcely commenced taking in coals. Many collieries appear to have taken on more tonnage than they can comfortably load during the remainder of this week and next, and it is not surprising that both exporters and shipowners feel some anxiety seeing that, if the coal negotiations do not shortly take a favourable turn, the possibility exists of not being able to get coals at all for their boats now in dock or due to arrive, as the collieries themselves will probably consider it necessary to reserve for the use of their own boilers in case of a stoppage of work in the coalfield sufficient coals to last them for a few weeks. Business actually passing on the market for prompt shipment is negligible, for the reason that the collieries have not got the coals to offer, while as regards next month foreign consumers do not appear to be interested at all, unless they can effect their purchases at a price which, at the moment, is considered by exporters as too low and risky. If there is no stoppage the conditions for the collieries next month will, it is feared, be very bad, as the normal flow of operations has been interrupted, and it will take several weeks at least for things to settle down. As regards the supply of coal over a period, it is interesting to find that the French State Railways have bought through various local coal exporters 80,000 tons of Welsh small coals for delivery from May to December. It is now pretty well a year ago that the French State Railways closed down their office at Cardiff and practically gave up taking coals from this district. It is reported that the business now concluded has been arranged on the basis of 16s. 1½d. per ton c.i.f. North French ports. Tenders had also to be in at Cairo on Wednesday of this week for the Egyptian State Railways' requirements of 150,000 metric tons of Welsh large coals, but it is to be feared that the uncertain outlook will induce many exporters to refrain on this occasion from putting in prices.

Coalowners and Miners.

Towards the end of last week a fully representative conference of delegates from the South Wales coalfield met to consider the resolutions passed by the conference of the M.F.G.B., in London on April 9th, when it was recommended to the districts that no assent should be given to any proposal for a longer working day; that the principles of the national wage agreement, with a national minimum percentage, should be adhered to; and, further, that no proposal for reducing wages should be entertained. These resolutions met with unanimous support from the South Wales Conference. On Friday the secretary of the South Wales Coalowners' Association sent a letter to the secretary of the South Wales Miners' Federation in which the employers invited representatives of the workmen to a meeting in order to discuss the terms and conditions of work at the collieries on and after May 1st. The South Wales Miners' Federation through its secretary, rejected the coalowners' invitation, and its decision came before a meeting of the Coalowners' Association on Tuesday, when Mr. Edmund L. Hann presided, and consideration was given to the terms and conditions on which collieries will be open for work as from May 1st. What the conditions are to be has not so far been disclosed, but it is expected that they will very shortly be posted up at the various collieries.

Docks Traffic.

The Great Western Railway Company's returns of traffic at the docks in this district under its control show that, for the four weeks ended March 21st, there was a reduction of 35,000 tons as compared with the previous four weeks, but there was this satisfactory feature, that the export trade alone touched figures which were higher than any during the previous fifteen months.

Waterworks Engineer Resigns.

On account of advancing age and indifferent health, Mr. C. H. Priestley, M. Inst. C.E., has resigned his position as waterworks engineer to the Cardiff Corporation. He will be seventy-two years of age on the 27th inst. On the 26th prox. it will be forty-five years since he commenced duty as assistant water engineer, and on June 25th it will be thirty-one years since he took up the position under the Corporation as waterworks engineer.

Current Business.

There has been next to no business during the past week, for the reason that the collieries have so little coal to sell for this month's loading. What sales have taken place have been in respect of very small parcels, and collieries have practically been able to name their own prices. The market would, however, be better described as nominal, though quotations range up to 27s. for best Admiralty large coals and up to 18s. 6d. or 19s. for best steam small coals. Most collieries are withholding quotations for May shipment.

CATALOGUES.

PETTERS, Ltd., Yeovil.—Catalogue describing the latest type of surface ignition engines; also one dealing with S type engines.

HENRY WILD SURVEYING INSTRUMENTS SUPPLY COMPANY, Ltd., Heerbrugg, Switzerland.—Booklets on "Wild's" precise level.

HUGHES, BOLCKOW AND CO., Ltd., Marske-by-the-Sea, Yorks.—Catalogue of pulley blocks, lifting tackle and hoisting appliances.

THE PULSOMETER ENGINEERING COMPANY, Ltd., Reading.—Booklet entitled "The Turbine Pump—What it Is and What it Does."

THE LE BAS TUBE COMPANY, Ltd., Dock House, Billiter-street, E.C. 3.—An abridged catalogue of G.F. malleable pipe fittings.

THE "S.-C." REGULATOR MANUFACTURING COMPANY, Fostoria, Ohio, U.S.A.—Catalogue No. 40 of "S.-C." steam regulation equipment.

RANSOMES AND RAPIER, Ltd., 32, Victoria-street, S.W. 1.—Brochure illustrating and describing the uses of the petrol-electric mobile crane.

CHARLES CHURCHILL AND COMPANY, Limited, 9-15, Leonard-street, E.C. 2.—Sample tin and descriptive folder of "Saroul," a new cleanser.

BRUCE PEEBLES AND CO., Ltd., Edinburgh.—Pamphlet No. 16 D, dealing with "Peebles" self-contained type alternating-current motors.

THE CAMBRIAN WAGON COMPANY, Ltd., East Moors-road, Cardiff.—Catalogue of rolling stock for the conveyance of merchandise by rail.

CONTRACTS.

LIGHT RAILWAYS, Ltd., of 2, London Wall-buildings, London, E.C. 2, has received from the Royal State Railways of Siam an order for 150 four-wheeled metre-gauge, all-steel, covered goods wagons.

FOAMITE FIREFOAM, Ltd., of 24-26, Maddox-street, Regent-street, London, W. 1, informs us that the G.T.S. Maid of Orleans is being fitted with a complete Foamite installation for the protection of her boiler-rooms.

FERRANTI, Ltd., of Bush House, London, W.C. 2, has received from the Sydney Municipal Council an order for six 10,000-kilovolt-ampère, three-phase transformers, 33,000 volts; and an order from the Public Works Department, New Zealand, for seven 5000-kilovolt-ampère, single-phase transformers, for use as 15,000-kilovolt-ampère three-phase groups, 110,000 volts. The approximate total value of these two orders is £40,000.

THE EAST FERRY-ROAD ENGINEERING WORKS COMPANY, Ltd., has received from the Port of London Authority a repeat order for twenty-seven portable hydraulic luffing cranes. These cranes are to be of the portal type and of 30 cwt. capacity at a maximum rake of 65ft. and a minimum of 20ft., with a total lift of 95ft. They are to be capable of luffing through the full radius at the rate of 150ft. per minute, and of slewing with the full load at the rate of one revolution per minute. The lifting speed is to be 250ft. per minute.

SWEDISH INDUSTRIES FAIR.—The Swedish Industries Fair will be held at Gothenburg from May 6th to 13th next in the extensive exhibition building of 30,000 square metres floor area, which was originally erected for the engineering section of the Gothenburg Exhibition a few years ago, and which is said to be the biggest timber structure in the world. The Fair this year will be particularly comprehensive, and certain sections, such as those dealing with leather and rubber goods, wireless apparatus, travelling requisites, arts and crafts, and a separate department of inventions, should be especially attractive and interesting. In connection with the Fair there are to be held a Gas Appliances Exhibition and a Sports and Camping Exhibition. The offices of the Fair are 18, Östra Hamngatan, Göteborg, Sweden.

B.E.S.A. ELECTRIC CABLE SPECIFICATION.—A revised edition of the B.E.S.A. Publication No. 7–1926, British Standard Specification for Insulated Annealed Copper Conductors for Electric Power and Light, has recently been issued by the British Engineering Standards Association. Few changes were found necessary in this revision, as was to be expected in a work of this character, although those made are of importance. One extra standard size (0·85 square inch) has been added to the list of stranded cables. Tables have been included to cover the thicknesses of vulcanised bitumen insulated and sheathed cables. A full list of definitions relating to conductors and cables has also been included. Copies of this revised specification may be obtained from the B.E.S.A. Publications Department, 28, Victoria-street, London, S.W. 1, price 1s. 3d. each post free.

INSTITUTION OF NAVAL ARCHITECTS.—The Council of the Institution of Naval Architects has accepted an invitation to hold a summer meeting in Belgium where the Institution will be welcomed by the civic authorities in Brussels and Antwerp. A detailed programme of the meeting is in course of preparation by local committees in Belgium. The arrangements provisionally fixed are as follows:—Monday, June 21st.—Proceed from London to Brussels, *viâ* Ostend. The following two days will be spent in Brussels, where an official reception will take place and visits will be paid to the principal places of interest in the capital. Thursday, June 24th: Proceed from Brussels to Antwerp, where the Burgomaster will receive the guests and a banquet will be held. Friday and Saturday, June 25th and 26th: Reading of papers and visits to works and places of interest in Antwerp and the neighbourhood. Sunday, June 27th: Return by special steamer from Antwerp to London, *viâ* Zeebrugge and Dover.

"EXPLOSIVE REACTIONS IN GASEOUS MEDIA."—A general discussion on this subject is being organised by the Faraday Society to take place on Thursday, May 13th, at the Institution of Mechanical Engineers, Storey's-gate, Westminster, S.W. 1. The proceedings will be divided into two sessions. The first, from 2.30 to 6.30, will deal with the subject generally, and Professor H. B. Dixon, F.R.S., will preside. An introductory survey will be given by Dr. W. E. Garner, and papers initiating discussion will be presented by Professor Dixon, Professor W. T. David, Dr. S. W. Saunders, Dr. R. V. Wheeler, Professor W. A. Bone and Dr. C. Campbell. The second session, 7.45 to 10, will deal with explosive reactions considered in reference to internal combustion engines. Sir Dugald Clerk, F.R.S., will preside, and he will give an introductory survey, being followed by Professor David and Mr. H. T. Tizard. A dinner will be held between the sessions at the St. Ermin's Hotel. A full programme can be obtained on application to Mr. F. S. Spiers, 90, Great Russell-street, London, W.C. 1.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
Native	18/- to 21/-
(1) Spanish	18/- to 21/-
(1) N. African	18/- to 21/-
N.E. Coast—	
Native	—
Foreign (c.i.f.)	21/3

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	3 17 0	—
No. 1 Foundry	3 19 0 to 4 1 6	
No. 3 Foundry	3 16 6 to 3 19 0	
N.E. Coast—		
Hematite Mixed Nos.	3 16 0	3 16 0
No. 1	3 16 6	3 16 6
Cleveland—		
No. 1	3 13 6	3 14 0
Silicious Iron	3 12 6	3 13 0
No. 3 G.M.B.	3 10 0	3 10 6
No. 4 Foundry	3 9 0	3 9 6
No. 4 Forge	3 8 6	3 9 0
Mottled	3 8 0	3 8 6
White	3 8 0	3 8 6
Midlands—		
(5) Staffs.—		
All-mine (Cold Blast)	10 10 0	—
North Staffs. Forge	3 17 6	—
,, ,, Foundry	4 7 6	—
(3) Northampton—		
Foundry No. 3	3 3 0 to 3 4 0	
,, Forge	2 15 0 to 2 16 0	
(3) Derbyshire—		
No. 3 Foundry	3 6 0 to 3 7 0	
Forge	3 0 0 to 3 2 0	
(3) Lincolnshire—		
No. 3 Foundry	3 8 0	—
No. 4 Forge	3 5 6	—
Basic	3 6 0	—
(4) N.W. Coast—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 7 6 (a) / 4 10 0 (b) / 4 15 0 (c)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	11 5 0	11 0 0
Best	—	—
N.E. Coast—		
Common Bars	11 0 0	—
Lancs.—		
Crown Bars	11 0 0	—
Second Quality Bars	9 15 0	—
Hoops	14 0 0	—
S. Yorks.—		
Crown Bars	12 10 0	—
Best Bars	13 10 0	—
Hoops	14 10 0	—
Midlands—		
Crown Bars	11 0 0 to 11 10 0	
Marked Bars (Staffs.)	14 0 0	—
Nut and Bolt Bars	10 5 0 to 10 10 0	
Gas Tube Strip	12 5 0 to 12 10 0	—

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates	11 0 0	—
Ship Plates, ½in. and up	7 12 6	7 0 0
Sections	7 2 6	6 5 0
Steel Sheets, under 3/16in. to ½in.	8 15 0 to 9 0 0	
Sheets (Gal. Cor. 24 B.G.)	—	£15 15s. to £16 10s.

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	7 12 6	—
Angles	7 2 6	—
Boiler Plates	11 10 0	—
Joists	7 2 6	—
Heavy Rails	8 0 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	8 2 6	—
Soft Billets	7 5 0	—
N.W. Coast—		
Barrow—		
Heavy Rails	8 0 0†	—
Light Rails	8 5 0 to 8 10 0	
Billets	7 10 0 to 9 0 0†	
Manchester—		
Bars (Round)	8 0 0 to 8 5 0	
,, (others)	8 0 0 to 8 5 0	
Hoops (Best)	13 5 0	13 0 0
,, (Soft Steel)	10 0 0	9 15 0
Plates	7 17 6	—
,, (Lancs. Boiler)	11 10 0	—
Sheffield—		
Siemens Acid Billets	10 10 0	—
Bessemer Billets	11 5 0	—
Hard Basic	8 12 6	—
Intermediate Basic	8 2 6	—
Soft Basic	6 15 0	—
Hoops	12 0 0	—
Soft Wire Rods	9 10 0	—
Midlands—		
Small Rolled Bars	7 15 0 to 8 0 0	
Billets and Sheet Bars	6 0 0 to 6 2 6	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	15 10 0 to 16 0 0	
Angles	7 2 6	—
Joists	7 2 6	—
Tees	8 2 6	—
Bridge and Tank Plates	7 17 6	—
Boiler Plates	11 0 0 to 11 10 0	

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	19/1½ to 19/6
Block Tin (cash)	279 0 0
,, (three months)	267 5 0
Copper (cash)	56 17 6
,, (three months)	57 15 0
Spanish Lead (cash)	27 18 9
,, (three months)	28 8 9
Spelter (cash)	31 17 6
,, (three months)	32 5 0
Manchester—	
Copper, Best Selected Ingots	61 15 0
,, Electrolytic	65 10 0
,, Strong Sheets	90 0 0
,, Tubes (Basis Price)	0 1 0½
Brass Tubes (Basis Price)	0 0 11½
,, Condenser	0 1 2
Lead, English	30 5 0
,, Foreign	29 2 6
Spelter	32 17 6

FERRO ALLOYS.

(*All prices now nominal.*)

	Per Ton.	Per Unit.
Tungsten Metal Powder	2/1 per lb.	
Ferro Tungsten	1/9½d. per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£22 10 0	7/6
,, 6 p.c. to 8 p.c. ,,	£22 0 0	7/3
,, 8 p.c. to 10 p.c. ,,	£20 15 0	6/6
,, Specially Refined		
,, Max. 2 p.c. carbon	£38 10 0	12/6
,, ,, 1 p.c. ,,	£44 10 0	15/-
,, ,, 0·70 p.c. carbon	£54 10 0	17/6
,, ,, carbon free	1/5½d. per lb.	
Metallic Chromium	3/3 per lb.	
Ferro Manganese (per ton)	£15 for home, £15 for export	
,, Silicon, 45 p.c. to 50 p.c.	£11 15 0 scale 5/- per unit	
,, ,, 75 p.c.	£20 10 0 scale 6/- per unit	
,, Vanadium	14/6 per lb.	
,, Molybdenum	6/- per lb.	
,, Titanium (carbon free)	0/11½ per lb.	
Nickel (per ton)	£170	
Cobalt	10/- per lb.	
Aluminium (per ton)	£112	

FUELS.

SCOTLAND.

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	15/9
,, ,, Ell	16/-
,, ,, Splint	16/9 to 18/3
,, ,, Trebles	16/-
,, ,, Doubles	14/-
,, ,, Singles	13/6
Ayrshire—	
(f.o.b. Ports)—Steam	16/-
,, ,, Jewel	16/9
,, ,, Trebles	17/-
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	12/6 to 14/9
Screened Navigation	21/-
Trebles	14/- to 14/9
Doubles	14/-
Singles	13/-
Lothians	
(f.o.b. Leith)—Best Steam	14/6
Secondary Steam	13/6
Trebles	14/9
Doubles	14/-
Singles	13/-

ENGLAND.

(8) N.W. Coast—	
Steams	23/-
Household	40/- to 48/-
Coke	24/-
Northumberland—	
Best Steams	16/-
Second Steams	14/6 to 15/-
Steam Smalls	8/- to 8/6
Unscreened	13/- to 13/6
Household	20/- to 22/-
Durham—	
Best Gas	18/6 to 19/-
Second	15/- to 15/6
Household	20/- to 22/-
Foundry Coke	18/- to 20/-

Sheffield	Inland.	
Best Hand-picked Branch	31/- to 34/-	—
Barnsley Best Silkstone	28/- to 30/-	—
Derbyshire Best Brights	26/- to 28/-	—
,, ,, House	24/- to 25/-	—
,, ,, Large Nuts	17/- to 20/-	—
,, ,, Small	12/6 to 14/-	—
Yorkshire Hards	17/- to 19/6	—
Derbyshire Hards	16/- to 19/-	—
Rough Slacks	10/- to 12/6	—
Nutty Slacks	7/6 to 9/-	—
Smalls	3/6 to 6/-	—
Blast-furnace Coke (Inland)*	—	—
,, ,, (Export)	f.o.b.	16/- to 17/-

(9) SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Smokeless Large	26/- to 27/-
Second ,, ,,	25/- to 25/6
Best Dry Large	24/- to 26/-
Ordinary Dry Large	21/- to 22/-
Best Black Vein Large	26/- to 26/6
Western Valley Large	25/6 to 26/-
Best Eastern Valley Large	25/- to 25/6
Ordinary ,, ,,	24/- to 25/-
Best Steam Smalls	18/- to 18/6
Ordinary ,,	17/- to 18/-
Washed Nuts	19/- to 26/-
No. 3 Rhondda Large	27/- to 28/-
,, ,, Smalls	18/- to 18/6
No. 2 ,, Large	24/- to 25/-
,, ,, Through	20/- to 21/-
,, ,, Smalls	15/- to 16/-
Foundry Coke (export)	40/- to 50/-
Furnace Coke (export)	25/- to 30/-
Patent Fuel	22/- to 24/-
Pitwood (ex ship)	26/- to 26/6
Swansea—	
Anthracite Coals:	
Best Big Vein Large	39/- to 40/-
Seconds	32/6 to 35/-
Red Vein	27/- to 29/-
Machine-made Cobbles	50/- to 52/6
Nuts	50/- to 52/6
Beans	42/6 to 44/-
Peas	23/- to 25/-
Breaker Duff	7/6 to 8/-
Rubbly Culm	12/- to 13/-
Steam Coals:	
Large	22/6 to 24/6
Seconds	20/- to 22/-
Smalls	11/- to 15/-
Cargo Through	16/6 to 17/6

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayreshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. * For blast-furnaces only, 17/-, with fluctuations according to analysis; open market 17/6 to 19/- at ovens. † Latest quotations available. (a) Delivered Glasgow. (b) Delivered Sheffield. (c) Delivered Birmingham.

French Engineering Notes.

(From our Correspondent in Paris.)

Selling Prices.

MANUFACTURERS are beginning to lose the habit of basing their selling prices upon the internal value of currency. It is obviously unsafe to take as a basis a value which is being constantly depreciated by financial deficits at home and by the fluctuations of the franc abroad. So long as makers were able to provide a reasonable margin for probable increases in prices of raw material and higher charges, they were in a fairly sound position, but with the heavier taxation and the general feeling that the financial situation has become desperate, unless handled with care, there is no means of insuring a safe margin, except by approaching more closely to the gold standard. In some cases, even, it has become the practice to quote for export in sterling and dollars, and that serves as a standard for prices at home. Thus there is a continued advance in prices, while frequently new lists are set out with a notable increase and a statement that any further taxes and charges will be added to them. As a matter of fact, we have entered upon a period when the prices of everything are advancing far more rapidly than the depreciation of the franc. One reason for this is seen in the extraordinary increase in the value of raw material imports. During the first three months of the year there was a decline of 83,732 tons in the quantity of raw material imported, as compared with the first quarter of 1925, and the value increased by 3598 million francs. At the same time, with an augmentation of only 76,003 tons of exports, the value increased by 2327 million francs. While a year ago the value of exports was far in excess of that of imports, the position is now reversed, and while during the three months imports totalled 11,720,772 tons, with a value of 14,823 million francs, the exports amounted to 7,941,606 tons, with a value of 13,237 million francs. Manufactured goods were exported to the amount of 1,110,627 tons, and were valued at 8336 million francs, which value is relatively much higher than previously. All this points to the gradual levelling up of French prices to those abroad.

Coal Strikes.

The International Miners' Committee has held a meeting in Brussels to consider what action should be taken to help the British miners in the event of their deciding to come out on strike. As is usually the case at these deliberations, it was decided to prevent shipments of coal to England should that be necessary, and a resolution was passed stating what should be done in the event of an international strike being declared. This may have given satisfaction to the British delegates, but, as a matter of fact, the prospect of an international strike is extremely remote, for the reason principally that with the existing stocks of coal and the poverty of the miners' unions on the Continent, the chances of the men being able to stand out long enough would be very small indeed. Moreover, the French miners in particular will never strike in sympathy with their British comrades, nor will they take any active measures to prevent consignments of coal to England, even if they were able to do so. They do not forget that not long after the Armistice the British miners failed them in a similar case. One point in the resolutions of the Brussels Committee meriting attention was the suggestion that the only way out of the difficulties that are confronting all the colliery districts was to examine the possibility of coming to an international agreement with regard to the production and distribution of coal. In other words, the Committee hopes that it will be possible to do with coal what is already being done with certain steel products. The over-production is to be met by each country having a definite participation in the foreign trade.

Case-hardening.

At the Académie des Sciences, M. Léon Guillet, whose researches regarding, and experiments with, the heat treatment of steels and with steel alloys generally have given such interesting and valuable results, presented a note on a new method of case-hardening, based upon the action of nitrogen upon steels discovered by Mr. A. Fry. By this method certain steels can be machined and given an extremely hard surface without the necessity of grinding. After machining, the steel is heated in an ammoniacal current at a temperature of 500 deg. to 510 deg. Cent. If the steel be suitable for the treatment, such as aluminium steel, the hardening takes place slowly, and in four days it penetrates to a depth of 8/10 mm. The researches of M. Guillet show that the hardening is only possible in steels containing certain elements which combine with the nitrogen to form a resistance to penetration, for with ordinary steels the "nitruration" takes place very rapidly, and tends to penetrate the mass, with the result that it forms what M. Guillet calls "needles of 'nitrure' of iron," which render the metal very fragile. With chromium, silicon, and especially aluminium, a very hard surface is formed, much harder than that obtained with the usual case-hardening process.

Russian Trade.

For more than two months past a Russian delegation has been installed at the Ministry of Finance, with a view of discussing and settling, if possible, the various questions that at present hinder the carrying out of a satisfactory commercial agreement between the two countries. It would appear that some sort of compromise is being effected, for France is very desirous of obtaining from Russia all the oil she can and of being able to find in that country a market for manufactured goods. An arrangement of this kind would not be possible without a State control over the distribution of oil, and the attempt of the Government to introduce a monopoly into the Budget proposals was dictated solely by a desire to conclude a convention with the Soviet, whereby this country would be supplied with Russian oils. The fear of complications with the United States, the certainty that the financial burden would be too great at the present moment and the general distrust of State monopolies brought about its rejection, for the time being at any rate.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

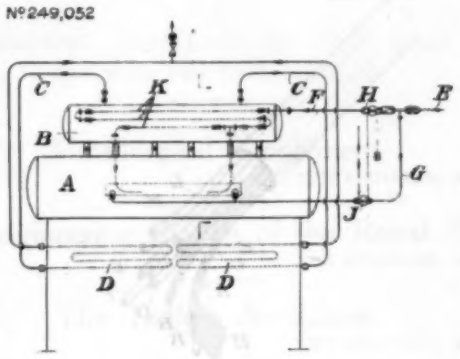
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

249,052. December 14th, 1925.—REGULATING THE TEMPERATURE OF SUPERHEATED STEAM, *Babcock and Wilcox, Ltd., Babcock House, Farringdon-street, London, E.C.* 4.

This invention aims at the automatic regulation of the temperature of superheated steam. In the drawing A represents the steam drum of a boiler, above which there is mounted a secondary drum B. Saturated steam is taken by the pipes C C

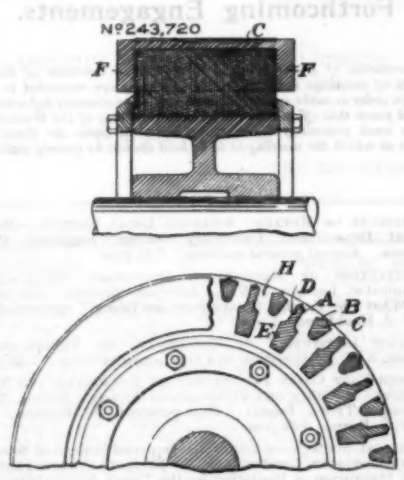


to the superheaters D D. The feed water is supplied at E and goes through two branches F and G to the boiler. These branches are controlled by interconnected valves H and J, which are connected with a "heat-absorbing body and a regulating device not shown." The effect of this device is to divert more or less of the cool feed water into the coil K in the top steam drum, and thus chill the outgoing steam to an extent dependent on the final temperature.—*March 18th*, 1926.

DYNAMOS AND MOTORS.

243,720. November 23rd, 1925.—IMPROVEMENTS IN AND RELATING TO ELECTRIC MOTORS, *The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C.* 2.

The induction motor described in this specification is claimed to have a better starting torque and a higher efficiency and very slightly lower power factor at normal speeds than ordinary squirrel-cage induction motors, and better characteristics than double squirrel-cage induction motors as hitherto constructed. The rotor core is provided with alternate deep slots A and shallow slots B. The latter contain a single conducting element

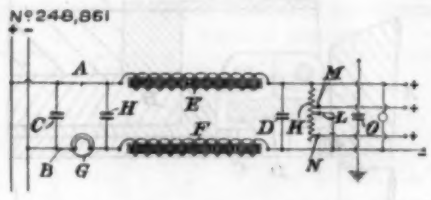


C, whereas the deep slots A have two conducting elements D and E. All of the conducting elements in all the slots are shown connected together at the ends by short-circuiting end rings F, one at each end of the rotor core. The conducting elements C in the shallow slots and the elements D in the top of the deep slots are connected together to form a high resistance, low reactance squirrel-cage winding and the conducting elements E in the bottom of the deep slots are connected together to form a low resistance, high-reactance, squirrel-cage winding. The teeth H formed between the deep and shallow slots are substantially uniform in cross section, whereby uniform magnetic density in the teeth is obtained.—*March 18th*, 1926.

TELEGRAPHS AND TELEPHONES.

248,861. December 18th, 1924.—IMPROVEMENTS IN MEANS FOR SUPPLYING ELECTRIC CURRENT TO WIRELESS APPARATUS FROM DIRECT-CURRENT SUPPLY MAINS, Frank Baker and Sons, Ltd., of 27 to 29, St. Paul's-square, Birmingham, and Frederick Charles Clarkson, of 909, Stratford-road, Hall Green, Birmingham.

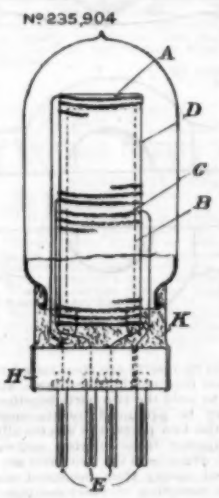
This invention relates to means for supplying electric current to wireless apparatus from direct-current electric supply mains, and particularly for supplying the current necessary for maintaining the anodes of thermionic valves at a positive potential without the use of high-tension batteries, as well as, if desired, for supplying the low-tension current for heating the filaments. The object of the present invention is to provide improved and more efficient means for reducing the voltage of the supply to that which is required, and at the same time smoothing out or reducing to a minimum the effect of commutator ripple. The supply leads A and B are shunted at two points by two condensers C D, across which alternating potentials due to the alternating or fluctuating ripple-producing component of the supply current, are set up. Iron core chokes E and F, each having a resistance of from 500 to 1000 ohms, are connected in series with each lead, and in the negative lead B between the first condenser C and the choke coil F there is an incandescent lamp G or neon tube, which serves to reduce the voltage at the output ends of the leads, which are connected to the wireless set. The two leads A B are also shunted by a third or intermediate condenser H connected to the negative lead at a point between the incandescent lamp or neon tube G and the choke coil F and to the positive lead A at a point between the first condenser C and the choke coil E. All three condensers may be of about 2 microfarads, and they may, if desired, be variable. Connected



in shunt across the leads, upon the output side of the condensers and choke coils, is a variable resistance K, one end being permanently connected, for example, to the positive lead A and the other end being free. Associated with the resistance K is a slider L connected to the negative lead, so that by varying the position of contact of this slider the amount of resistance in shunt is correspondingly varied. The two leads on the output side of the resistance are taken to the wireless apparatus, and by suitably varying the resistance L the potential applied across the terminals of the wireless apparatus may be regulated as may be required. One or more sliders or adjustable tappings, such as M N, may also be employed on the resistance, where it is desired to apply different voltages to the anodes of different valves, such as detector and amplifying valves. A condenser O may be employed in the earth connection from the wireless set to prevent short-circuiting of the supply mains or low-tension battery.—*March 18th*, 1926.

235,904. June 18th, 1925.—APPARATUS FOR USE IN INSTALLATIONS FOR AMPLIFYING ELECTRIC OSCILLATIONS BY MEANS OF DISCHARGE TUBES, N. V. Philips' Gloeilampenfabrieken, of Emmasingel 6, Eindhoven, Holland.

This specification describes a self-contained resistance capacity coupling for use on wireless receiving sets. The amplifying resistance A, the condenser B and the leakage resistance C, connected in a correct manner, are arranged in a closed exhausted container to form a self-contained unit provided with four contact-making members E. In an amplifying apparatus, it is therefore possible to interpose between every successive valve an apparatus which ensures a much simpler mounting of a

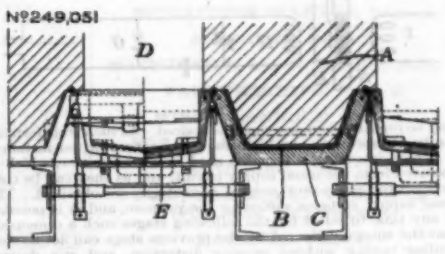


receiving set than usual. The condenser B is constructed as a wound condenser and is arranged within a vessel D of insulating material, such as glass. The space between the condenser and the vessel D is filled with paraffin. On the outer wall of the vessel D the resistances A and C are wound. These resistances consist of resisting wire, constantan, for example, which is helically wound on a core of insulating material—such, for example, as asbestos or yarn. The two ends of each resistance are connected to two of four contact pins secured in the disc H of insulating material. The disc H is connected by a metal ring K to a glass bulb surrounding the members, and the bulb is exhausted.—*March 18th*, 1926.

GAS PRODUCERS.

249,051. December 9th, 1925.—COKE OVENS, A. Beckers, 36, Luttringhauserstrasse, Köhln-Kalk, Germany.

The masonry of the oven fronts A is first completely covered



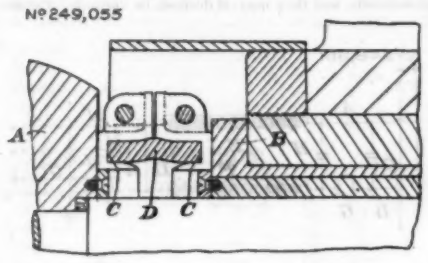
with a layer B of insulating material, and this is then enclosed by iron frame plates C, which form an integral member for each oven front or may be composed of a number of plates fitted

together. The oven chambers D are in this case provided with self-packing doors E. In this manner both the radiation of heat from the furnace heads, as also the escape of gas and air from the chambers and the admission of air into the chambers and heating flues is prevented with certainty. By preventing the radiation of heat from the oven fronts a very efficient heating of the ends of the chamber is effected.—*March 16th*, 1926.

SHIPS AND BOATS.

249,055. January 7th, 1926.—Stuffing-boxes for Stern Tubes, L. Ferguson, P. Ferguson and R. Ferguson, Newark Works, Port-Glasgow.

For the purpose of making an oil and water-tight joint between

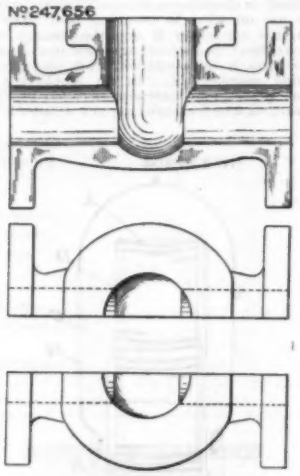


the propeller boss A and the stern-tube liner B, the inventors employ two split annular channel-shaped rings C C, which are pressed apart by means of the compressed rubber ring D.—*March 18th*, 1926.

MISCELLANEOUS.

247,656. November 19th, 1924.—Improvements in the Production of Hollow Steel Stampings for use as Valve Bodies or for other Purposes, Sir John Dewrance, of 165, Great Dover-street, Southwark, London.

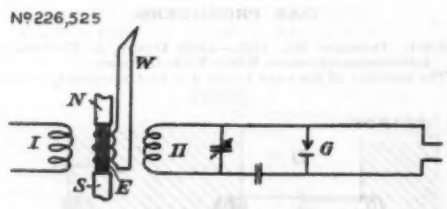
This invention relates to the production of hollow steel bodies by stamping and welding processes, and the bodies may be used, for example, as casings or "shields" for valves, particularly those intended for superheated steam and high-pressure fluids generally. Each half body is gradually shaped by repeated pressings in suitable dies and annealings, until it assumes the



desired form. The two parts are then raised to a welding heat, placed face to face together between jaws, and subjected to a pressure in order to weld the two parts together. The necessary welding heat may be produced by transmitting an electric current through the two parts, the electrically imperfect joint between their adjacent faces offering sufficient resistance to cause their fusion, whereupon the two parts are pressed together. The wrought steel casing thus produced may be internally machined for the reception of valve seatings.—*February 19th*, 1926.

226,525. December 9th, 1924.—An Improved Alternating-current Relay, Heinrich Konemann, of Werse 12a, Mauritz, Munster, Westphalia, Germany.

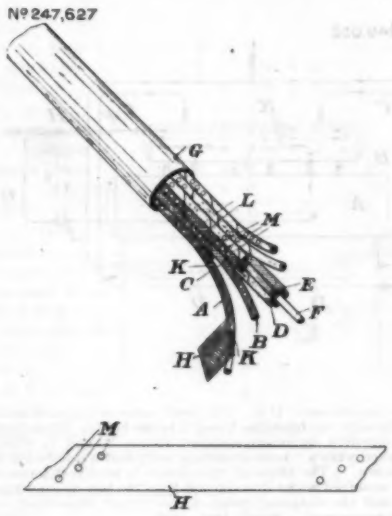
According to this invention use is made of a frequency changing transformer of small dimensions which is controlled by means of small energies, for instance, microphone currents, the oscillations produced in the secondary circuit being converted into continuous currents by means of a rectifier, through which the groups of impulses flow, the integral of which corresponds to the microphone currents. The modulations thereby produced in the continuous-current circuit are led by a cascade arrangement to a second transformer of larger dimensions, and this operation



may be repeated as many times as desired. As such transformers can be connected to any high-frequency generator, for instance, to a high-frequency alternator used as a transmitter, which is operated from the usual supply circuit, and as they can be constructed for any power, several advantages are obtained. The usual supply voltages suffice for the purpose, and it is possible at any time to select for the following stages such a dimension that the energy delivered by the previous stage can act as controlling energy without causing distortion, and any desired energy can be obtained. In the diagram E is a finely subdivided pre-magnetised iron core energised by means of a high-frequency circuit I, whereby oscillatory currents are produced in a circuit II which is tuned to a frequency equal to n times the frequency of the circuit I, the currents having a maximum value for a definite preliminary magnetisation. As the degree of the preliminary magnetisation can be varied by means of the controlling winding W, the amplitude of the secondary currents can be varied by varying the current in this winding. With each oscillation of the secondary circuit II the latter now sends a current impulse in the continuous-current circuit through the rectifier G. The current impulses correspond to the amplitudes of the oscillations of the circuit II, so that the integral of the groups of impulses corresponds to the modulations in the winding W. The continuous-current circuit in its turn serves as a controlling circuit for a second relay of correspondingly larger dimensions, in which the operations are repeated with larger energies. The invention extends to the limiting case where the ratio of the frequencies of the primary and secondary circuits is 1 : 1.—*March 4th*, 1926.

247,627. October 18th, 1924.—Improvements in Electric Cables, Callender's Cable and Construction Company, Ltd., of Anchor Works, Leigh, in the County of Lancaster, and Stanley James Bryce, of the same address.

The object of this present invention is to allow an unlimited number of cable cores or conductors to be individually identified without involving undue expense or other disadvantages. The cable illustrated comprises a number of cores A, B, C, D, E, F, &c., individually insulated and within a common sheathing G,



which may be either of lead, rubber or other material. Each insulated conductor forming an individual core of an electric cable is provided with a helical wrapping or tape H of paper, linen or similar material, which has one or a group of punchings K, L, M, spaced along it, the punchings differing for each core. Preferably the punchings such as M are arranged diagonally across the paper or similar strip, so that when this is wound helically round the cable, these punchings lie in a straight line along the axis of the cable, and can be therefore more readily distinguished.—*February 18th*, 1926.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

Institute of Metals: Swansea Local Section.—Metallurgical Department, University College, Singleton Park, Swansea. Annual general meeting. 7.15 p.m.

Institution of Mechanical Engineers.—Storey's-gate, Westminster, London, S.W. 1. Informal meeting. Discussion on "What Our Foreign Competitors are Doing," introduced by Mr. F. J. Hookham. 7 p.m.

Junior Institution of Engineers.—39, Victoria-street, London, S.W. 1. Question and Discussion evening. 7.30 p.m.

North-East Coast Institution of Engineers and Shipbuilders.—Literary and Philosophical Society's Rooms, Newcastle-upon-Tyne. Paper, "High-powered Oil Engines," by Mr. W. S. Burn. 7.30 p.m.

Physical Society of London.—Imperial College of Science, South Kensington, London, S.W. 7. Eleventh Guthrie Lecture, "The Absorption of Radiation by the Upper Atmosphere," by Professor Charles Fabry. 5 p.m.

Royal Institution of Great Britain.—21, Albemarle-street, London, W. 1.—Discourse, "Luminous Discharge Through Rare Gases," by Professor R. Whiddington. 9 p.m.

SATURDAY, APRIL 24TH.

Institute of Marine Engineers.—85/88, The Minories, Tower-hill, London, E. 1. Juniors' Social and Dance. 7 p.m.

MONDAY, APRIL 26TH.

Institution of Structural Engineers.—Abbey House, Victoria-street, London, S.W. 1. Students' meeting. Discussion on "Theory *versus* Practice," opened by Mr. Ewart S. Andrews. 6 p.m.

Railway Club.—65, Belgrave-road, London, S.W. 1. Paper, "The Principles of Signalling," by Mr. L. Hiller. 7.30 p.m.

TUESDAY, APRIL 27TH.

Institute of Metals: North-East Coast Local Section.—Electrical Engineering Theatre, Armstrong College, Newcastle-on-Tyne. Annual general meeting. 7.30 p.m.

Institution of Civil Engineers.—Great George-street, London, S.W. 1. Paper, "The Triple-expansion Steam Engine, as Applied to the Pumping of Water; with Special Reference to the Plant at Lea Bridge," by Mr. H. R. Lupton. 6 p.m.

Junior Institution of Engineers.—Monico Restaurant, Piccadilly-circus, London, W. 1. Annual dinner. 6.30 for 7 p.m.

WEDNESDAY, APRIL 28TH.

Institution of Automobile Engineers.—Birmingham Graduates' Visit to the Works of Morris Engines, Ltd., Gosford-street, Coventry.

Institution of Automobile Engineers: North of England Centre.—College of Technology, Manchester. Lecture on "L.G.O.C. Methods of Omnibus Repair," by Mr. G. Rushton. 7.30 p.m.

Institution of Mining and Metallurgy.—Geological Society's Rooms, Burlington House, Piccadilly, London, W. 1. Annual general meeting. 5.30 p.m.

Newcomen Society.—Prince Henry's Room, 17, Fleet-street, London, E.C. 4. Paper, "The Stevens Family, Engineers and Inventors," by Commander A. D. Turnbull. 5.30 p.m.

Royal Microscopical Society: Industrial Applications' Section.—20, Hanover-square, London, W. 1. Paper, "Some Micro-structural Features of Modern Rustless Steels," by Mr. J. H. G. Monypenny. 7.30 p.m.

Royal Society of Arts.—John-street, Adelphi, London, W.C. 2. "Horse Traction and Motor Traction," by Mr. J. Paterson. 8 p.m.

THURSDAY, APRIL 29TH.

Engineering Golfing Society.—The course of the Beacons field Golf Club. Spring Meeting. 10 a.m.

Illuminating Engineering Society.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Discussion on "School Lighting," opened by Dr. James Kerr. 7 p.m.

Institution of Electrical Engineers.—Savoy-place, Victoria Embankment, London, W.C. 2. "The Frequency Characteristics of Telephone Systems and Audio-frequency Apparatus and their Measurement," by Messrs. B. S. Cohen, A. J. Aldridge and W. West. 6 p.m.

Institution of Locomotive Engineers.—The Engineers' Club, Coventry-street, London, W. 1. Paper, "Steam Locomotive Performance," by Mr. T. Grime. 7 p.m.

Royal Institution of Great Britain.—21, Albemarle-street, London, W. 1. "The Imperfect Crystallisation of Common Things," by Sir William Bragg. 5.15 p.m.

FRIDAY, APRIL 30TH.

Institution of Electrical Engineers: Scottish Centre.—Y.M.C.A. Hall, Constitution-road, Dundee. Lecture, "The Past, Present and Future Development of Wireless Telephony," by Captain P. P. Eckersley. 7.30 p.m.

Institution of Mechanical Engineers.—Storey's-gate Westminster, London, S.W. 1. Informal meeting. Discussion, "Marine Oil Engines in Practice," introduced by Mr. C. W. J. Taffs. 7 p.m.

Junior Institution of Engineers.—Royal United Service Institution, Whitehall, London, S.W. 1. Gustave Canet Memorial Lecture, "Air Transport," by Air Vice-Marshal Sir W. Sefton Brancker. 7.30 p.m.

Royal Institution of Great Britain.—21, Albemarle-street, London, W. 1. Discourse, "Wireless in the Empire," by Dr. W. H. Eccles. 9 p.m.

SATURDAY, MAY 1ST.

Institution of Municipal and County Engineers.—South-Eastern District meeting at Margate. 11 a.m.

Royal Institution of Great Britain.—21, Albemarle-street, London, W. 1. Annual meeting. 5 p.m.

THURSDAY, MAY 6TH.

Institution of Automobile Engineers.—Cavendish Café, Cornmarket, Derby. Derby Graduates' meeting. Paper, "Inspection in the Building of an Automobile Chassis," by Mr. J. Topham. 7.30 p.m.

THURSDAY AND FRIDAY, MAY 6TH AND 7TH.

Iron and Steel Institute.—Institution of Civil Engineers, Great George-street, London, S.W. 1. Annual meeting. For programme see page 447. 10 a.m. each day.

FRIDAY, MAY 7TH.

Chemical Engineering Group.—Florence Restaurant, 56, Rupert-street, London, W. 1. Annual general meeting and informal dinner. 6.30 p.m.

Electrical Association for Women.—Criterion Restaurant Piccadilly, London, W. 1. Luncheon. 1 p.m.

WEDNESDAY, MAY 19TH.

Institute of Metals.—Institution of Mechanical Engineers, Storey's-gate, London, S.W. 1. Annual May Lecture, "Single Metallic Crystals and their Properties," by Professor H. C. H. Carpenter. 8 p.m.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

The Stereophagus Pump and Engineering Company, Ltd., asks us to announce that its address in future will be 40, Broadway, Westminster, London, S.W. 1 (telephone, Victoria 9554).

The General Development Company, Ltd., asks us to announce that it has changed its address from 4, Henry-street, Gray's Inn-road, London, W.C. 1, to 104, Victoria-street, Westminster, S.W. 1.

Fescol, Ltd., formerly of Penarth-street, Canterbury-road, Old Kent-road, London, S.E. 15, requests that in future all communications and all work shall be sent to its new works, 101, Grosvenor-road, Westminster, London, S.W. 1 (telephone, Victoria 2622 and 2623).

J. M. Wotherspoon and Co., Ltd., of 194–200, Bishopsgate, E.C., inform us that their board has been strengthened by the addition of Mr. H. F. Hedge, who for many years—1899 to 1920—was associated with Kilburn Brown and Co., of Orient House, New Broad-street, E.C., and Calcutta.

Mr. H. C. Amos, A.M.I. Mech. E., of 22, Martin-lane, Cannon-street, London, E.C. 4, advises us that as from April 1st last he has acquired and will carry on in his own name the business established by Mr. E. C. Amos in 1888. Mr. H. C. Amos will continue the London representation of several British machine tool and other manufacturers with which he has been connected for many years.

Engineers' Scales.—We have received from Mr. W. Mavitta, Park-road, Aston, Birmingham, a sample of his patented celluloid cased draughtsman's scale. It is claimed for it that the casing will not strip or come loose, that the scale will not shrink, and that it is as suitable for hot as for cold climates. It has a very neat appearance, and is as legible as one made of ivory. It has a boxwood core, which is only visible at the ends, the casing covering it completely elsewhere. We understand that the price is the same as for ordinary celluloid edged scales, and that these scales can now be purchased from the ordinary dealers.